THE

JOURNAL

OF

THE LINNEAN SOCIETY.

BOTANY.

VOL. XXVII.

LONDON:
SOLD AT THE SOCIETY'S APARTMENTS, BURLINGTON HOUSE,
AND BY
LONGMANS, GREEN, AND CO.,
AND
WILLIAMS AND NORGATE.
1891.

Dates of Publication of the several Numbers included in this Volume.

No. 181,	pp.	1–112,	published	April 5, 1890.
,, 182,	,,	113–205,	,,	May 3, 1890.
,, 183–184,	,,	205–332,	,,	August 16, 1890.
,, 185–186,	,,	333–457,	,,	November 13, 1890.
,, 187–188,	,,	457–562,	,,	April 25, 1891.

PRINTED BY TAYLOR AND FRANCIS,
RED LION COURT, FLEET STREET.

LIST OF PAPERS.

EXPLANATION OF THE PLATES.

Plate		
I.	Erythrina aurantiaca, Ridl.	To illustrate Mr. H. N. Ridley's paper on the Botany of Fernando Noronha.
II.	Cyperus circinatus, Ridl. Oxalis sylvicola, Ridl.	
III.	Sapium sceleratum, Ridl.	
IV.	Paspalum phonoliticum, Ridl.	
V. VI. VII.	Illustrating Mr. G. Massee's paper on the Thelephoreæ.	
VIII.	Catasetum Darwinianum, Rolfe, to illustrate Mr. R. A. Rolfe's paper on the Sexual Forms of *Catasetum*.	
IX. X. XI.	Illustrating Dr. F. Buchanan White's paper on British Willows.	
XII.	Dictyosphærium Ehrenbergianum, Näg., to illustrate Mr. G. Massee's paper, Life-History of a Stipitate Freshwater Alga.	
XIII.	Structure of Dictyopteris. Illustrating Prof. Thos. Johnson's paper on the Systematic Position of the Dictyotaceæ, &c.	
XIV.	Proteid Reactions of Callus. To illustrate Mr. Spencer Moore's paper on the Nature of Callus.	

THE JOURNAL

OF

THE LINNEAN SOCIETY.

NOTES ON THE BOTANY OF FERNANDO NORONHA.

By H. N. RIDLEY, M.A., F.L.S.

[Read 7th June, 1888.]

(PLATES I.–IV.)

INTRODUCTION.

ON July 9th, 1887, the writer, with Mr. G. A. Ramage, of Edinburgh, started for Brazil to thoroughly explore the island of Fernando Noronha, lying in long. 32° 25′ 30″ W. and lat. 3° 50′ 10″ S., at a distance of 194 miles N.E. from Cape San Roque, coast of Brazil. On arriving at Pernambuco we were joined by the Rev. T. S. Lea, who came as a volunteer at his own expense. The cost of the expedition was defrayed by the Royal Society. After some delay at Pernambuco we embarked in the 'Nasmyth' steamship, trading to Liverpool, which was permitted to land us at the island, as the regular steamer trading between Pernambuco and Fernando Noronha was delayed for a long time just as she was due to start. We arrived at our destination on August 14th, and remained there till September 24th, when we returned by the little Brazilian steamer to the mainland. During our stay we were very hospitably entertained by the Capitao J. A. F. de Mendonça, the Governor of the island, who provided us with board, lodging, and horses, and a very intelligent and

useful negro convict as a guide. We occupied ourselves in exploring and collecting plants, animals, and rock-specimens in all parts of the main islands, and visited also most of the other islets which were accessible; but owing to the absence of boats, which are not permitted on the island, we were unable to obtain much by dredging. The coral-reefs, however, at low tide afforded an abundant harvest of marine animals and plants. When we arrived at the islands the rains had just ceased, and the herbaceous plants were in flower; as we left the dry season was commencing, and the herbs were withering and the trees and shrubs were beginning to flower. Several of these latter, indeed, only commenced to flower just a day or two before we left; so that we were only able to procure a few flowers, and in two instances only flowers of one sex, and the fruits also were unprocurable. This latter defect, however, was in some measure made up for by the kindness of the Director, who after our return sent a box of carefully labelled fruits and seeds of some of the rarer plants. The nesting-season of the birds had just begun, and we were able to procure nests of two of the endemic land-birds. The sea-birds apparently nested somewhat earlier, as we found young birds almost ready to fly of several species. The insects were tolerably plentiful; but we were rather late for Lepidoptera, and the Coleoptera also seemed not to be at their best.

During our visit we had only one or two wet days, and usually the sky was bright and clear, with a strong breeze from the south-east. During December, January, and February we were informed that the island becomes very dry. Most of the streams and puddles are dried up and water is scarce. All the herbaceous plants of the central districts wither, and are set fire to, so as to clear the ground.

General Account of the Group.

The whole group of islands forms a chain about eight miles in length, and probably at no very distant date were all connected. Indeed there is very good evidence to prove that the whole was at one time of much larger extent (see p. 17, note, and the Geological Report, pp. 86–94).

The largest island is the main one, about five miles in length and nearly two miles across in one spot, viz. near Tangle Rock, but otherwise very much narrower. The next in size is Rat

Island (Ilha dos Ratos), about a mile long, the most easterly of the group. Next to it, and apparently comparatively recently separated from it, is Ilha do Meio, or Booby Island. Then follows Sella Giueta, called in the Admiralty chart St. Michael's Mount*, a large phonolite peak rising straight from the sea; and between that and the main island is a low, flat, coral-reef island like that of Ilha do Meio, called Ilha Raza, or Egg Island, a little north of which are a few rocks forming a connexion with San José, or Platform Island, on which are the remains of a fort. On the south of the main island lie, at intervals, several rocky islets almost entirely barren of vegetation; and on the north side are two very similar conical basalt rocks known as Dois Irmaos.

Rat Island is a basaltic island of some size, the eastern end of which terminates in lofty crags, the haunt of numerous sea-fowl. The cliffs are lower on the north and south-eastern sides, and the ground slopes away to the west, where the basalt is overlaid by a considerable deposit of coral-reef, which, again, is covered with a layer of guano. At one point on the south-east corner the waves have eroded the reef so as to form a blowhole through which the spray rushes with great violence, so that the fountain can be seen at a distance of five or six miles. Round this blowhole was found *Sesuvium distylum*, n. sp., forming bright yellowish-green patches. The guano-ground was covered with a thick growth of *Ipomœa Batatas*, *I. pentaphylla*, *Phyllanthus*, *Momordica Charantia*, *Phaseolus lunatus*, *Ricinus communis*. Further inland the chief vegetation consisted of *Scoparia dulcis*, *Cyperus ligularis*, *C. brunneus*, *Æschynomene hispida*; while on the cliffs were the usual cliff-flora of this district—*Canavalia obtusifolia*, *Philoxerus vermicularis*, *Cereus insularis*, &c.

The only plants found here, and nowhere else in the island, were *Scoparia purpurea*, n. sp., *Sesuvium distylum*, *Cenchrus viridis*.

Owing probably to want of shelter from the winds there are no trees on the island, the Fig, *Ficus Noronhæ*, being reduced to a large shrub. There were a considerable number of weeds introduced by man, due partly to the settlement of Capt. Roma

* Most of the names on the Admiralty chart given by the French and English expeditions sent to the island are utterly unknown to the inhabitants of the island, whose nomenclature I have preferred in this report.

in the island for the purpose of working the guano. But the island has been inhabited to a certain extent at some time, as it is said that refractory convicts were formerly turned loose on the island by way of punishment.

There is a good permanent spring of water on the north side of the isle. The fauna includes, besides sea-birds, a Dove, *Zenaida Noronhæ*; but the Tyrant and *Vireo* found on Fernando Noronha are here absent. A Lizard and an *Amphisbæna* are both very abundant. Insects were very plentiful, though only a few species were taken; and one of the endemic mollusca was plentiful on the west coast.

The next island is Ilha do Meio, and, like the adjacent portion of Rat Island, it consists of a thick deposit of coral-reef overlying the basalt. As mentioned above, it is evidently only a detached portion of Rat Island, and probably but recently separated. The surface is very flat, so that no bushes or trees can grow upon it, excepting that upon the cliff-faces Cacti, *Oxalis Noronhæ*, and other plants exist, being protected from the wind.

The reef is worn into holes and caves, and the low cliffs shelter many nesting sea-birds, whence its name of Booby Island.

Sella Giueta, or St. Michael's Mount, is a peak of phonolite rising almost vertically from the sea, and, owing to the violence of the surf beating on it, is very difficult of access. It was visited by Professor Moseley during the 'Challenger' expedition, and is covered, where the surface of the rock permits it, with an abundant native flora, including *Sapium*, *Capparis Cynophallophora*, *Cereus insularis*, *Oxalis Noronhæ*, *Dactylæna micrantha*. As it has never been inhabited, all the weeds of cultivation except *Amaranthus* are absent; but the Lizard is abundant and large, and tamer here than on the other islands. A few insects occurred, and the Dove was plentiful, but neither the *Vireo* nor the Tyrant. Several of the sea-birds nest here, including the Tropic-bird (*Phaethon æthereus*) and the Frigate-bird (*Fregata aquila*).

From the fauna and flora of this spot it appears that the island was stocked while still connected with the other islands.

The islands lying between the Sella Giueta and the main isle call for little remark. The biggest is Ilha Raza, or Egg Island. It much resembles Ilha do Meio in form and structure, and the flora is similar. San José, or Platform Island, is connected with the main island by a ridge of basalt-rock only exposed at very low

tides, as indeed is the preceding island. An old ruined fort surmounts Platform Isle, in the ruins of which we found numerous plants of *Solanum paniculatum*, and *Ipomœa Tuba*, while other species were common. A weak hairy form of *Eleusine ægyptiaca* occurred, and a single specimen of a new species of *Pupa* was found beneath a stone. The island is remarkable from the fact that the coral-reef here is much higher than that of the adjacent islands, 95 feet above sea-level. On the summit of the island were some large blocks of sandstone, apparently formed of blown sand containing shells.

The main island is long and narrow in outline, about five miles in length, and nearly two in breadth at Tobacco Point, where it is broadest. The centre of the island forms an undulating plateau about 200 feet above sea-level, sloping upwards at the western end, and terminating in a long, narrow, inaccessible promontory known as Cape Placellière. The cliffs are high and often perpendicular, sometimes descending into the sea, but often with sandy bays at the foot. At the eastern end of the island the ground slopes away to sea-level, and here are extensive sand-hills covered with *Ipomœa Pes-capræ*, *Pavonia cancellata*, and *Sida altheæfolia*. The soil of the central district is a fertile red clay, formed by disintegration of the basalt which forms the bulk of the island. This portion is mostly under cultivation, and the flora consists for the greater part of introduced weeds, but here and there are a few endemic plants. The hills are cultivated also almost to the summits here; but upon the East Hills, the Peak, and Tangle Rock were obtained a number of native species, growing mingled with weeds of cultivation. Two species of plants, viz. *Combretum* sp. and *Aspilia Ramagii*, were only found on the East Hills; while the Peak and Tangle Rock, both phonolite rocks, produced several endemic species. The western end of the island is covered with dense forest, but large trees are now not common, owing to the demand for firewood and to the strict orders for the destruction of all large trees to prevent the convicts making rafts of them on which to escape. This portion of the island is termed the Sapate; the chief trees and shrubs there are *Sapium sceleratum*, *Bignonia* sp., *Schmidelia insulana*, *Jacquinia armillaris*, *Oxalis Noronhæ*, *Bumelia fragrans*, n. sp., *Anacardium occidentale*, *Palicourea* sp., *Pisonia Darwini*, *Spondias purpurea*, *Jatropha Pohliana*, *Capparis Cynophallophora*, *C. frondosa*, and *Croton* sp. Except along the paths in the wood there is very

little undergrowth in the Sapate; but a new species of *Oxalis* was obtained at one spot. At the entrance to this district, along the path used by the woodcutters, a number of weeds occurred, not common elsewhere, which were no doubt introduced by the wood-cutters themselves, such as *Plumbago scandens* and one or two large patches of *Panicum numidianum*. The latter is the cultivated fodder-grass of Brazil, and from its position here it appeared to have been brought in the form of hay for the horses used in carrying the wood from the forests.

There is a large pool of water of considerable depth on the south side of the Sapate; it is surrounded at some distance by a semicircle of high cliffs, between which and the lake is a dense thicket of shrubs, which come down to the very edge. The lake is fringed with *Panicum brizoides* and almost filled to the brim with *Nitella cernua* and an Alga, among which we found many specimens of a new species of *Planorbis* and several aquatic insects not met with elsewhere. On Morro branco, a hill composed of phonolite altered by contact with basalt, a few local plants were found, and a peculiar *Paspalum* with stiff erect leaves (*P. phonoliticum*). Wherever the cliffs were broken up they were covered with a vegetation of maritime plants, such as *Canavalia obtusifolia*, *Philoxerus vermicularis*, *Ipomœa Tuba*, *I. Pes-capræ*, *Cenchrus echinatus*, &c.

History.

The island was first discovered by Amerigo Vespucci in 1503, in his fourth voyage. A fleet of vessels having been despatched from Spain under Coelho, sailed first to the Canary Islands, then to Sierra Leone, and thence attempted to reach Bahia, which had been discovered during a previous voyage in 1501. The discoverer published his account of the finding of the island in the 'Lettera di Amerigo Vespucci delle Isole nuovamente trovate in quattro suoi viaggi,' from a translation of which (Quaritch, 1885, p. 43) I take the following account:—"And when we had sailed full 300 leagues through the immensity of the sea, being then quite 3 degrees south of the equinoctial line, we became aware of a land from which we were probably 22 leagues distant: whereat we marvelled: and we found that it was an island in the middle of the sea and was very lofty, a very marvellous work of nature; since it was no more than two leagues in length and one in breadth: in which island never had there been in habitation

by any people, and it was Bad Island for all the fleet, for your Magnificence must know that by the ill-counsel and steering of our Chief Captain he lost his ship here: since he struck with it upon a rock, and it split open on St. Laurence's night, which was on the 10th day of August, and went to the bottom: and there was nothing saved thereof except the crew. It was a ship of 300 tons; in which went all the importance of the fleet; and when all the fleet had laboured to save it, the Captain commanded me to make with my ship for the said island to seek a good anchorage where all the ships might anchor: and as my boat manned with 9 of my sailors was in service and aiding to belay the ships, he willed that I should not take it and that I should proceed without it: telling me that they should take it to me to the island. I quitted the fleet for the island as he ordered me, without a boat, and with the deficiency of half my crew, and I went to the said island, which was about 4 leagues distant: in which I found an excellent harbour, where all the ships could anchor very safely: where I awaited my Captain and the fleet fully 8 days, and they never came: so that we were very discontented, and the men that had remained with me in the ship were in such dread, that I was unable to console them; and being thus, the eighth day we beheld a ship coming upon the sea, and from fear that it might not see us, we weighed with our ships and made for it, thinking that it brought me my boat and crew." However, the rest of the fleet with the boat had gone further south (p. 44); so "We returned to the island and provided ourselves with water and timber by means of my companion's boat, which island we found uninhabited, and it contained many fresh and sweet waters, innumerable trees full of so many sea- and land-birds that they were beyond count, and they were so tame that they allowed themselves to be taken with the hand, and so many of them did we take that we loaded a boat with those animals. We saw none (other) except very large rats and lizards with two tails and some snakes." ["Infinitissimi arbori plena di tanti uccelli marini e terrestri che eron senza numero, . . . et tanti ne pigliamo che carichamo un battello di epsi animali; nessuno non vedemo; salvo Topi molto grandi e Ramarri con due code et alchuna serpe."—*Lettera*, Fiorenza, 1505; Quaritch's Reprint, London, 1885 (unpaged).

They then made provision, and departed by the wind between S. and S.W. for Bahia, which they reached in seventeen days, and it was 200 leagues from the island.

Some geographers seem to have been doubtful as to what this island described by Vespucci was, and several other islands were suggested, including the mythical St. Matthew's Isle and St. Paul's Rocks; but the position assigned by Vespucci, and the presence of abundant fresh water and trees, negative this suggestion. Humboldt and most other geographers, however, seem to agree that this island was certainly Fernando Noronha.

There are several very interesting points in the account quoted above. First, the author merely mentions one island. Now, without doubt the whole chain was connected at one time, but whether or not it was so when Vespucci discovered it must remain doubtful. The wrecked ship was lost probably off Rat Island, the first point that they would come to; and if Vespucci anchored in San Antonio Bay, on the north side, which is the nearest good anchorage, he would, as he says he was, be unable to see the rest of the fleet, owing to the high ground of Rat Island between him and it. His description of the trees and innumerable birds is evidently correct, though most of the trees are destroyed, and the birds far less abundant than they were then. The lizards with two tails may have been a confusion of the very abundant and conspicuous Gecko with the *Amphisbæna*, which is often called the snake with two heads, or may have been suggested by finding an accidentally fork-tailed lizard, an example of which monstrosity was obtained by our expedition. The serpents were doubtless the *Amphisbæna*. But the large rats are much less easy to explain; at present the only rats occurring on the island are *Mus rattus*, the common introduced black rat. It is impossible that the animals seen by Vespucci could have been this species, which could not at that time have been introduced. Is it not probable that there was formerly an indigenous rat-like mammal, exterminated by the introduction of the black rat? We could find no tradition even of this big rat, and I fear it is quite extinct. The only hope of recovering its remains lies in the guano deposits of Rat Island, where its bones might be preserved.

Origin of the Flora.

Before suggesting an origin or origins of the present Flora of the group, it must first be pointed out that there is no evidence whatever to show a former connection with the mainland of Brazil at any time, in spite of what has been asserted by Dr. Rattray

(Quart. Journ. Geol. Soc. xxviii. p. 33) to the contrary. There are no sedimentary rocks on the island, and granite, the prevailing rock in the neighbourhood of Pernambuco, is entirely absent, while at the same time no basaltic or phonolitic rocks are known from the adjacent mainland*. The "Tertiary conglomerates" of Rattray, showing a former connection with the Tertiary rocks of the adjacent mainland, are quite mythical. In spite of all attempts, it seems quite impossible to fix certainly the period at which the island rose from the bed of the ocean. That it is of considerable antiquity there is little doubt, however. From the petrological structure of the island it seems certain that it rose from the bottom of the ocean at some remote period, and of course when this happened there was no vegetation upon it. How is the present Flora to be accounted for? Most of the plants may be relegated to one of three classes:—Weeds, or plants introduced intentionally or accidentally by man; plants of which the seeds or fruits are known to be carried about the ocean by currents; and plants with eatable fruit which is sought by birds.

Weeds.

To this class belong many of the species. They include all the Malvaceæ and nearly all the Leguminosæ, the remainder being scattered over other orders. Most of them are plants of world-wide distribution and very common on the adjacent mainland. Few or none occur on the smaller islets, such as Sella Giueta; but where there have been settlements these plants seem to spring up at once. By far the greater number were to be found on the main island in the open central district and in the village. Only one occurred on Sella Giueta, and that was *Euxolus viridis*. To this section belong all or nearly all the plants with adhesive fruits or seeds, viz.:—*Desmodium* (4 species), *Æschynomene*, *Zornia*, *Plumbago*, *Boerhaavia* (2 species), *Chloris* (2 species), *Eragrostis ciliaris*, *Anthephora*, *Cenchrus* (2 species), *Setaria scandens*.

The absence of these from the smaller islets seems to show that the bird-fauna is not responsible for their presence here;

* When comparing Fernando Noronha with the adjacent continent, it is but just to point out that the nearest point, Cape San Roque, and indeed the whole of the Province of Rio Grande del Norte, is almost entirely unknown as regards its geology and natural history, and that even in the neighbourhood of Pernambuco much remains to be done.

for, as we shall see, the plants whose seeds are eaten by the birds, and the *Gonolobus*, whose downy seeds line the nest of the Tyrant, are carried about everywhere. But, on the other hand, where the convicts had made paths through the woods, and especially where they were able to take the horses for the purpose of fetching firewood, these weeds had followed and established themselves.

Plants introduced by Sea-currents.

Mr. W. B. Hemsley, in Bot. Voy. Chall. pt. iii. App. pp. 277–313, has given a good account of all that is at present known about these plants, but much yet remains to be ascertained. I fear I can add but little, for though both at Pernambuco and on Fernando Noronha we carefully sought for drift-fruits and seeds, we were only rewarded by finding two seeds of *Mucuna ureus* in Sueste Bay, a plant not yet established there. The current which strikes the island of Fernando Noronha is one which passes up along the east coast of Brazil. This current would naturally strike the island on its south side, and would bring with it seeds from the southern regions of Brazil. It would be aided also at the time of year at which we were upon the island by the trade-winds, which blow from the south-east, and, indeed, we found upon the sands of the bays on that side numerous marine plants and oceanic animals, such as *Velellas*, *Physalias*, and *Ianthina*, which we did not see at all on the northern side, besides the above-mentioned seeds of *Mucuna*. But there are a number of plants upon the island of which the seeds are known to be carried about the sea in this way, having been met with in sea-drift. These are *Canavalia obtusifolia*, *Rhynchosia minima*, *Abrus precatorius*, *Acacia Farnesiana*, *Ipomœa Tuba*, *I. Pes-capræ*, *I. pentaphylla* ?, *Philoxerus vermicularis*, *Talinum patens*, *Portulaca oleracea*, *Ricinus communis*, *Laguncularia racemosa*. Besides which, species of the genera *Sesuvium*, *Erythrina*, and *Pisonia*, each of which here supplies an endemic species, have been met with as drift-seeds.

Jatropha Pohliana and *J. urens*, both common on all parts of the main island, and also on Rat Island, are probably also drift-seeded plants. The bark and wood of the former was very common on the shores at Pernambuco.

Canavalia and *Philoxerus* occurred all along the coasts of Rat Island and the main island, and very rarely went very far from the beach. *Acacia Farnesiana* may have been introduced by

man, as it did not grow away from cultivation; and I suspect also that *Portulaca* is here at least a weed of cultivation rather than a sea-drifted plant, with which Mr. Hemsley classes it. *Ricinus* is very widely spread over the islands, and is most probably introduced by sea-currents. The convicts used to say that wherever the ground was dug *Ricinus* used to come up. Very possibly some of the other hard-seeded Euphorbiaceæ, *Euphorbia comosa*, *E. hypericifolia*, which always grows on the shore, and *Croton odoratus*, were originally introduced by ocean-currents.

Ipomœa Tuba is interesting, as it is not known from Brazil south of Fernando Noronha, and is a native chiefly of the West Indies; and *Cyperus brunneus*, Sw., which is common here, has not been obtained anywhere out of the West Indies except Florida and Mexico, and is one of the few plants known from S. Trinidad, where it was obtained by Sir Joseph Hooker, and published under the name of *C. atlantica*, Hemsl.

Several species of plants which might be reasonably expected to have been drifted across do not occur, notably *Remirea maritima*, *Fimbristylis glomerata*, *Avicennia*, and *Conocarpus*, all common in the sands of the neighbouring mainland; and the Cocoa-nut appears also to have been a recent introduction by man, although the shores below Pernambuco are lined with groves of them.

Plants with Berries and Eatable Seeds.

To this group belong a large number of plants, including several endemic species. Two species of *Capparis*, several species of Cucurbitaceæ, including three species of *Ceratosanthes*, all endemic; two *Cayaponias*, and a *Momordica*, *Cereus*, *Palicourea*, *Guettarda*, *Bumelia*, *Physalis*, and *Ficus*, all endemic species; *Jacquinia*, *Vitis*, *Rauwolfia*, *Cordia*, *Rivina*, four *Solanums*. Besides these are several plants originally introduced by man intentionally, which are now scattered all over the main island by the birds: such are *Solanum oleraceum*, *Capsicum frutescens*, *Basella alba*, *Spondias purpurea*, *Anacardium occidentale*, *Carica Papaya*, and *Lycopersicon esculentum*. Now a considerable number of these are to be found on the smaller islands as well as in the most inaccessible spots of the main island. One *Capparis*, several Cucurbitaceæ, the *Cereus*, *Rivina*, and *Ficus* occur on Sella Gineta. The fig, indeed, grows in almost every spot at all suitable for it,

even on the highest parts of the inaccessible portion of the Peak, on the isolated rocks called Dois Ismaos, and in many high inaccessible crags.

There is only one fruit-eating bird upon the island, and that is the endemic dove, *Zenaida Noronhæ*, which is exceedingly abundant, and flies from island to island. The crops of the specimens shot we frequently found full of the *Cayaponia* fruits.

When one sees the number of endemic species with edible fruit, one is tempted to wonder if it were possible that they were all introduced by this single species of Dove, or whether other frugivorous birds may not at times have wandered to the shores.

One is too apt to imagine that only gaily coloured berries are attractive to birds, and we were thus puzzled to account for the *Sapium* occurring so widely over all the isles and in very inaccessible spots high upon the rocks; but we were informed by our guide that the small birds eat the seeds greedily and pass them uninjured, thus scattering them about the island. As the seeds are so poisonous that they are said to blister the skin of any horse or cow on which they fall, it is surprising to hear that the birds are fond of them.

THE RELATIONS OF THE FLORA TO THE INSECT FAUNA.

It will be noticed that there are in the Flora a considerable number of plants which require the aid of insects in fertilization. The Cucurbitaceæ, the Papaw, *Schmidelia*, *Combretum*, *Terminaliopsis*, are all diœcious, and not being anemophilous, must be fertilized by insects. *Oxalis Noronhæ* also has dimorphic flowers, implying the necessity of insect-fertilization. Many plants have showy coloured flowers, the commonest colour being yellow. *Datura Stramonium*, *Cereus insularis*, and *Ipomœa Tuba* are nocturnal plants with white flowers, very sweetly scented in the first two cases at least. Several species, such as *Urena lobata*, *Oxalis Noronhæ*, and the cultivated Cucurbitaceæ, open their flowers in the early morning, closing them when the sun gets hot, about 10 o'clock; *Palicourea* and *Bumelia* seem to be really diurnal, and are strongly scented during the daytime. All the plants above mentioned fruited very extensively on the islands, and the Leguminosæ and Cucurbitaceæ were especially productive.

The number of insects belonging to the orders which are well known as plant-fertilizers is surprisingly limited. A few

small species of moths haunted at night the bushes of *Scoparia dulcis*, *Cassias*, &c. on the open spaces. A single species of butterfly was very abundant on Rat and the main island, but we never saw it visiting flowers.

The most important fertilizer was a small endemic hornet belonging to the genus *Polistes*, which gathered honey from the Leguminosæ and Cucurbitaceæ; and three small black species of *Halictus* were caught in the flowers of the melons, *Momordica Charantia*, *Oxalis Noronhæ*, and the mustard. The latter plant was also haunted by *Temnoceras vesiculosus*, a pollen-eating Syrphid. The only other insects which could also be considered as possible fertilizers were *Tachytes inconspicuus*, n. sp., and *Monedula signata*, two sand-wasps, *Pompilus nesophila*, n. sp. (Hymenoptera), and *Psilopus metallifer* (a Dipteron), but none of these were seen at or near flowers. A small black beetle also was found in the flowers of an *Acacia* in the Governor's garden.

Though the number of species of insects was not large, yet the individuals, especially of the *Polistes* and *Halicti*, were very numerous, but at the same time they seemed out of all proportion to the immense number of flowers to be fertilized. It is very probable, however, that the majority of the Leguminosæ and some of the other plants were self-fertilized.

Groups of Plants rare or unrepresented.

The absence of plants or groups of plants from a given locality often throws as much light on the origin of the flora as the presence of others does. In the present case the absence of marsh-plants is among the most striking; for in the first place they are exceedingly abundant on the adjacent mainland, and, again, there is every reason for their being introduced by the wading-birds which fly across from Brazil. The genera *Eleocharis*, *Utricularia*, *Pœpalanthus*, *Saleria*, and many others remarkably abundant on the adjacent mainland, are here quite absent. Indeed, the only really marsh-loving plants met with were *Jussieua linifolia*, *Ammania latifolia*, and *Panicum brizoides*. The dryness of the island during the dry season accounts for this in the main; but there are spots which are permanently damp, and here one might reasonably expect to find marsh-plants. The chief plant which grows along the streams and on these damp spots is, however, *Philoxerus vermicularis*; and as the water has a brackish taste, it is probable that the salt or other

mineral matters in the soil prevent the growth of purely marsh-plants. The dryness of the climate is also no doubt the reason for the absence of sylvestral plants, the Sapate woods, where such plants would naturally occur, being dry and rocky.

The absence of petaloid Monocotyledons from oceanic islands has been commented on by Hemsley, Chall. Exp. Report, Bot. vol. i., and Fernando Noronha is no exception to the rule. Plants with winged or feathery seeds are supposed to possess great facilities for being widely disseminated. That this is really the case may be doubted. The only species with winged or plumed seeds here are *Gonolobus micranthus*, *Jussieua linifolia*, and *Ageratum conyzoides*. The first of these is endemic; its plumed seeds are used by the endemic Tyrant, *Elainea Ridleyana*, to line its nest with. Is it conceivable that the seeds of the ancestor of this plant were accidentally brought over attached to the feathers of some bird which had, in like manner, used them for its nest? *Jussieua* is a marsh-plant, with small seeds plumed like those of an *Epilobium*; it and the *Ageratum* only occurred in the cultivated ground in the centre of the island. The latter certainly, and possibly the former, were introduced as weeds by man.

Bromeliaceæ, though commonly provided with plumed seeds and abundant in Brazil, are quite absent here. In reality it would require a strong and very long-continued wind to carry plumed seeds to such a distance from the land, and even if such should be the case, the chances of seeds dropping upon a small island like this would be exceedingly remote.

Recent Alterations in the Flora.

When the island was first discovered in 1503, Vespucci found there infinite numbers of trees, most of which have now disappeared. Of *Erythrina exaltata*, mentioned by Webster as the largest tree in the island, only one full-sized tree now remains; and as it seems that the young trees will not flower, the species appears to be threatened with speedy extinction. Of the fig-tree, again, but few large ones remain, the finest being in the Governor's garden. This is due to an order of the government, which provides that all trees of a sufficient size to be made into rafts shall be destroyed, for fear that the convicts might escape on them; and besides this the constant demand for fire-wood causes great destruction amongst the smaller shrubs. I could not find, however, from the inhabitants, that any perceptible

diminution in the number of trees had occurred of late years, neither do the more recent accounts of Webster, Darwin, or Moseley lead one to suppose that the island was very much richer in trees than it is now.

Another cause for the change of the flora is to be seen in the more recently introduced plants, and the creeping and climbing plants seem to be rapidly destroying the older vegetation. The number of climbing plants on the island is very large, belonging chiefly to the orders Cucurbitaceæ and Leguminosæ. The former, especially *Momordica Charantia* and *Cayaponia Tajuga*, cover the trees and bushes on the edges of the forest with a dense mat of stems, so that they are soon suffocated and destroyed, and when they have fallen to the ground they are soon covered with a carpet of thickly woven stems of Cucurbitaceæ and Leguminosæ, of which *Phaseolus peduncularis* appears to be the most destructive, and on the ground thus once covered the shrubs can no longer reassert themselves. Furthermore during the dry season, December to February, these climbing-plants wither and dry up and are set on fire, and any seedlings of the shrubs which may have escaped strangulation by the climbers are destroyed. The conflict between the climbing-plants and the shrubs was very well seen all along the eastern edge of the Sapate. In the woods themselves these plants were entirely absent, since they were unable to grow among the dense shrubs, from want of light and air.

The Freshwater Fauna and Flora.

The number of permanent streams and pools in the whole Archipelago is very small, as in the dry season almost all dry up. There is a spring on Rat Island said to be never dry, and there are also one or two on the main island, where besides there is the largest stream at Sueste, and also the lake in the south-west corner, in both of which aquatic plants and animals might occur; none of these, however, are rich in fauna or flora. The lake contained a species of *Nitella* and an alga, an aquatic beetle and Hemipteron, a new species of *Planorbis*, and an Ostracod, the latter also occurring in all the streams of any size. The remaining streams and puddles produced dragonflies, a species of *Gammarus*, and a few algæ. One may compare this with the freshwater fauna and flora of the other Atlantic islands. The absence of freshwater fish and amphibians is common to most small islands.

Freshwater mollusks occur in several islands, including Madeira, where are a species of *Ancylus* and *Lymnæa*. The Azores possess no freshwater mollusk according to Godman, who attributes this to the paucity of waders and ducks inhabiting these islands, although he gives a very considerable list of swamp-loving birds as occasional migrants. In the Galapagos Islands a *Paludina* occurs.

Water-beetles are apparently always very rare in oceanic islands. Wollaston shows that the *Hydradephaga* are the most poorly represented group in the Atlantic islands visited by him (Coleopt. Atlantidum, Introd. p. xv). In St. Helena, too, there are none; and in Fernando Noronha they seem scanty.

Distribution of the Fauna compared with that of the Flora.

It is unfortunate that the naturalists who have visited oceanic or distant islands have usually examined into the distribution of one group, either plants or animals, or often but one order of the latter, so that it is very difficult to obtain any clear ideas as to the relations of the two groups. I have had in presenting these reports the assistance of my colleagues in the British Museum, and other English naturalists of the highest standing, and am therefore able to make a few observations on the distribution of both plants and animals as compared together.

Just as in plants, we have a considerable number of animals introduced by man into the islands intentionally and by accident: such, for instance, are the Gecko (*Hemidactylus mabouia*), the American Cockroach (*Blatta americana*), and its curious parasite *Evania*, a spider, centipede scorpion, rats and mice, *Sitoplidus oryzæ*. These, though usually plentiful on the main island around the houses, are markedly wanting from the smaller islets.

There is also a large group which has arrived here by the aid of their wings, probably assisted by a suitable wind. This includes a number of the peculiar terrestrial fauna, the land-birds and the insects. In looking over the lists of species taken here, we may note that the smaller birds are endemic, and a large proportion of the smaller insects. The small butterfly and almost all the moths are known from the mainland of South America, and the dragonflies are also widely distributed forms. All the winged fauna have a South-American facies, whether they are endemic or of wider distribution.

There is another group which is unprovided with means of traversing the ocean, and not carried about by man. This includes the *Amphisbæna*, Skink, the freshwater and terrestrial Mollusca, and perhaps some of the feebler-winged and apterous insects, the endemic ostracod, &c.

The *Planorbis*, *Gammarus*, and Ostracod, all (?) endemic species, it is quite conceivable may have been brought over on the feet of Waders, which seem to migrate here.

The remainder are more difficult to account for. The Mollusca are almost all peculiar, and the two that are not so are West-Indian. The *Amphisbæna* and Skink are endemic, and allied not to Brazilian but to West-Indian forms.

It is commonly said that reptiles and terrestrial mollusks find their way across the ocean by secreting themselves or their eggs in floating trees, which are drifted to islands; and though for several reasons this does not seem a satisfactory explanation of their distribution, yet the distribution of these animals here points to this as the means by which they have arrived. As I have said, they are West-Indian in facies, and correlated with this is the striking fact that the marine fauna and flora, and at least one of the plants whose seeds are known, supposed to be constantly drifted about the sea, and to be thus carried from place to place, is only known also from the West Indies (*Ipomœa Tuba*). Another fact of interest in connection with these sea-travelling fauna, if I may use the expression, is the fact that almost all occur on all the islands suited for their existence. Thus, on Rat Island the *Bulimus Ridleyi*, the *Amphisbæna*, and Skink are common on St. Michael's Mount; the Skink is a large species, but the island, being a mere rocky peak, is unsuited for the *Amphisbæna*.

On Platform Island the lizard and several terrestrial Mollusca were found, while at the same time almost all the animals of a more recent introduction were absent from these localities, just as is the case in the distribution of the plants. I believe, in fact, that this part of the fauna and flora was established on the island before it was broken up into the little archipelago of rocks and islets of which Fernando Noronha now consists *. Perhaps

* On reference to A. Vespucci's description of the place, it will be found that he speaks of it as one island, so the breaking-up into an archipelago may only have taken place within the last 400 years.

even this portion of the fauna and flora was introduced previously to the deposition of the basalt over the masses of phonolite, which form as it were the skeleton outline of the island.

I cannot find any recorded observations of the flow of a current in the sea now from the direction of the West Indies; on the contrary, the current marked on the maps, and which was certainly during our visit throwing up fleets of *Velellas*, *Physalias*, Algæ, and other marine drift, was flowing from the south. No *Physalias* or *Velellas*, nor anything of the kind was to be found on the north side of the group, although the former at least were very plentiful in the open sea to the north. It is true that we did find some pieces of rotten timber on the north side of the island at the foot of the cliffs of the Sapate, but they may have been, and I think were, portions of the mast of a ship. They were buried under débris from the cliff and quite decomposed. And, again, I should add that during our visit the wind blew from the south, while we were informed that at other seasons it blew strongly from the north.

Published Accounts of the Island.

The earliest account is that by Amerigo Vespucci, mentioned above. The next which I have been able to find embodying any notes on natural history is that published by Juan and Ulloa in their Voyage to South America. These travellers arrived there on their way north from Cape Horn on May 21, 1744. They describe the island as very barren, from want of rain, saying that previous to their visit there had been no rain for two years. However, it must be remembered that the time of their visit was not long after the end of the normal dry season. They mention abundance of fish, including lampreys and morenos (*Muræna*), and describe a fish called a cope.

In the account of the voyage of the 'Chanticleer,' under Capt. Henry Foster, Mr. Webster, in vol. ii. pp. 326–339 of his narrative of the Voyage, gives a very good account of the geology, and some remarks on the botany and zoology. Even at that time there were few large trees on the island, the commonest being the "Bara." He mentions the *Jatropha*, *Cassia occidentalis*, *C. falcata*, and several species of *Indigofera*. The largest trees on the island were the "*Erythrina exaltata.*" "The Acacias are the graces of the woods, and cast a sweet perfume around." By these I conclude he alludes to *Acacia Farnesiana*,

but it does not occur in the woods at present. He also talks of the "*Swartzea pennata*, Jajo," which was possibly *Swartzia pinnata*, Willd., sometimes cultivated in Brazil.

The animals collected by this expedition are in the British Museum. They include the skink, dove, tyrant, and also *Thysanodactylus lineatus*, a large lizard not known now to occur in the island; but as the expedition collected at other places, it is quite possible that this specimen may have been collected elsewhere and mislabelled. Mr. Webster remained on the island a month.

The 'Beagle' landed its crew on the island on Feb. 20, 1832, and Mr. Darwin visited the Peak and made geological notes upon it, and also collected a number of plants, now in the Cambridge Museum. He says "the whole island is covered with wood, but from the dryness of the climate there is no appearance of luxuriance."

In 1871, H.M.S 'Bristol' visited the island to take some altitudes, and Dr. Rattray published an account of the geology in the Geological Society's Quarterly Journal, vol. xxviii. pp. 31–34, and a popular account of the island in the Geographical Society's Journal. Of these it will be sufficient to say that the geological account and map are erroneous and misleading—the phonolite being spoken of throughout as granite, and the so-called granite being marked on spots where basalt only occurs, while "tertiary conglomerates" are recorded from various spots and correlated with those on the mainland of Brazil. What was intended by these "tertiary conglomerates" is not clear, but probably masses of basaltic beach-pebbles cemented together by gypsum, which occur in some at least of the spots where the tertiary conglomerates were found.

In Sept. 1873, H.M.S. 'Challenger' arrived at the island with intention of exploring it, but being unarmed with the requisite authority, were refused permission. Prof. Moseley, however, succeeded in obtaining a few plants, both from the main island and from St. Michael's Mount, which were described and figured in the Voyage of the 'Challenger' Report, Botany, pt. ii., by Mr. Hemsley*. The officers of the 'Challenger' also took soundings at various distances from the ship, and dredged at some little distance from it. The animals obtained are in the British Museum; the plants were divided between that institu-

* For an account of this visit, see Journ. Linn. Soc. xiv. (1875), pp. 359–362.

tion and the Kew Herbarium. From the published descriptions there seems to have been little alteration since the time of Ulloa's visit in the appearance of the island.

Besides the specimens of plants and animals mentioned above as having been collected by Webster, Darwin, and Moseley, there is a small early collection of seven specimens of plants in the British Museum by an unknown collector, apparently a foreigner, and a single specimen of *Capparis Cynophallophora*, from Capt. Middleton, at Kew.

Summary.

The whole group of islands possesses certain characteristics common to all truly oceanic islands, and some of those which are merely the relics of vanished continents. In the first place, there is the absence of indigenous mammals, and more noticeably of bats, of freshwater fish, and amphibians. Again, the number of indigenous species, both of plants and animals, is very small, while the number of individuals is very large. The insects are small and dull in colour, and but few of the plants have showy flowers, white and yellow being prevailing colours. A considerable proportion of the indigenous plants are shrubby or arboreous, as in many other oceanic islands; but arboreous or even shrubby Compositæ do not exist, indigenous species of the group being rare in the islands.

POLYPETALÆ.

CAPPARIDEÆ.

Capparis Cynophallophora, *L. Sp. Pl.* p. 721; *Jacq. Am. Pl.* p. 158; *Eichl. in Mart. Fl. Bras.* xiii. 1. p. 282.

A common shrub on the main island, especially in the Sapate and near Tobacco Point. It is also occurs on Sella Giueta. It attains a height of about 12 feet; but in open spots is much smaller. During our visit it was hardly in flower, very many plants showing no signs even of buds. One fruiting specimen occurred; but from the number of seedlings in some spots, there can be little doubt it fruits extensively at some seasons. The flowers are white and fugacious. The fruit a soft pulpy red pod. The plant is much infested with galls. It is called "Feijao de lenha."

It was also obtained by Moseley and by Middleton.

Distribution. Florida, Panama, Yucatan, Mexico, most of the West-Indian islands, Guayaquil, Venezuela, and Brazil as far south as Rio de Janeiro.

CAPPARIS FRONDOSA, *Jacq. Am. Pl.* p. 162, t. 104; *H. B. K. Nov. Gen. et Sp.* v. p. 91; *Eichl. in Mart. Fl. Bras.* xiii. 1. p. 280.

A large leafy shrub, very abundant in the woods around the lake and in the open parts of the Sapate. It is used for making hoops for barrels, &c. It is about 12 feet in height, and would probably become a larger plant, but is much cut for firewood. The flowers are very fugacious; the petals dull purplish green, the stamens white; the fruit resembles that of the preceding species, but is larger, and at first green, then purple-rose, and finally black; it never appeared to show any signs of dehiscing into two valves, as is represented in *C. flexuosa*, Vell. Fl. Flum. v. t. 108; but the fruit as it ripened became soft and pulpy. Mice are very fond of the seeds.

Native name "Gito."

Distribution. West Indies and Brazil.

CLEOME SPINOSA, *L. Sp. Pl.* p. 939; *Ait. Hort. Kew.* ed. 2, iv. p. 131; *Eichl. in Mart. Fl. Bras.* xiii. 1. p. 253.—C. pungens, *Willd. Hort. Berol.* t. 18.

A form with thorns and white petals and pink stamens. Occurred in the garden of the Residency and in waste places in the village. As it is used in medicine, it was doubtless introduced to the island by man. It is found in many places in Brazil in a half-wild state; and we met with almost the same form in waste places in the town of Olinda, Pernambuco.

C. DIFFUSA, *DC. Prodr.* i. p. 241; *Eichl. in Mart. Fl. Bras.* xiii. 1. p. 258.

Very plentiful at one spot upon the upper part of the Peak, growing among Cucurbitaceæ. Flowers white.

Distribution. Brazil.

DACTYLÆNA MICRANTHA, *Schrad. Hort. Goett.*; *Schult. f. in Roem. et Schult. Syst.* vii. p. 9; *Eichl. in Mart. Fl. Bras.* xiii. 1. p. 243.—Cleome monandra, *DC. Pl. Rar. Hort. Gen.* p. 54, t. 15.

Abundant along pathways through the Sapate, and also on Sella Giueta. Flowers pink.

Distribution. North Brazil, Bahia, and Pernambuco.

CRUCIFERÆ.

The Cabbage, *Brassica oleracea*, L., and Mustard, *Brassica alba*, Boiss., are both very successfully cultivated here, but not in any quantity.

ANONACEÆ.

Anona squamosa, *L. Sp. Pl. ed. Willd.* ii. p. 1265. no. 3.

There are several trees of this species on the island, at Sambaquichaba and Sueste. They fruit well.

PORTULACACEÆ.

Portulaca oleracea, *L. Sp. Pl.* p. 638; *Haw. Misc.* p. 126; *Rohrb. in Mart. Fl. Bras.* xiv. 2. p. 229.

Very common among the stones in the village, and also on the sea-shore on the north side, both of the main island and Rat Island.

Distribution. All over the warmer parts of the world.

Talinum patens, *Willd. Sp. Pl.* ii. p. 863; *Rohrb. in Mart. Fl. Bras.* xiv. 2. p. 296.—Portulaca patens, *Jacq. Hort. Vindob.* ii. t. 151.

Common on the main island in thickets near the sea. A specimen was found in Portuguese Bay nearly 6 feet in height. It is also abundant on Rat Island and St. Michael's Mount.

The flowers are usually pink; but white-flowered plants occur also.

Distribution. All Central and South America.

MALVACEÆ.

Pavonia cancellata, *Cav. Diss.* iii. p. 135; *DC. Prodr.* i. p. 444.

Plentiful on the sand-hills at San Antonio Bay.

Distribution. South America from Surinam, and Caracas.

Hibiscus esculentus, *L. Sp. Pl.* p. 980; *DC. Prodr.* i. p. 450.

Extensively cultivated as a vegetable, as elsewhere, in Brazil.

Gossypium barbadense, *L.*

The cotton grown here is of very fine quality; but it is but little cultivated.

URENA LOBATA, *L. Sp. Pl.* p. 974; *DC. Prodr.* i. p. 441.

A patch of plants of this species occurred among *Cassia* and *Crotalaria* on the hill above the garden of the Residency. The showy pink flowers closed before 10 A.M.

Distribution. Throughout the tropics of both hemispheres.

WISSADULA HIRSUTA, *Presl, Rel. Hænk.* p. 118; *Walp. Rep.* i. p. 328.

About a dozen plants grew among the bushes at the entrance to the Sapate woods. The flowers are yellow and rather showy. The plants were about 5 feet high.

Distribution. Brazil.

MALACHRA CAPITATA, *L. Syst.* ed. xii. p. 518; *DC. Prodr.* i. p. 440; *Griseb. Fl. Brit. W. Ind.* p. 80.

This was plentiful in the central district, growing with the Cassias, &c., in the Horta da Florestas. It is a coarse half-shrubby plant with white flowers. This is the species mentioned under the name of *M. radiata* by Hemsley in the Botany of the 'Challenger' Voyage, Atlantic Islands, p. 15.

Distribution. Most tropical countries.

SIDA ALTHEÆFOLIA, *Sw. Prodr.* p. 101; *Sw. Fl. Ind. Occ.* ii. p. 1207; *DC. Prodr.* i. p. 464.

On the sand-hills near Fort San Antonio. A stunted form, less pubescent than usual. Flowers buff.

Distribution. Yucatan, Guiana; Brazil, from Ceara to Rio de Janeiro; Peru; Jamaica and Senegal.

S. PANICULATA, *L. Sp. Pl.* p. 962; *DC. Prodr.* i. p. 465; *Cav. Diss.* i. p. 16.—S. atrosanguinea, *Jacq. Ic. Rar.* i. t. 136.

A common shrubby plant, with dark purple flowers. In many of the bushy places, on the main island, especially Chaloupe Bay, the Peak, and the Sapate.

Distribution. Jamaica; Peru; Ecuador; and Brazil, where it is common from Pernambuco? to Rio de Janeiro.

S. SPINOSA, *L. Sp. Pl.* p. 960; *DC. Prodr.* i. p. 460.

Frequent on the slopes of Chaloupe Bay, near the Fort.

Distribution. Cosmopolitan.

S. GLOMERATA, *Cav. Diss.* i. p. 18, t. 2. f. 6.—S. carpinifolia, *DC. Prodr.* i. p. 460.

Along the main roads through the central district. Common.

Distribution. Widely distributed.

STERCULIACEÆ.

Waltheria americana, *L. Sp. Pl.* ed. 1, p. 673; *H. B. K. Nov. Gen. et Sp.* v. p. 333; *Schum. in Mart. Fl. Bras.* fasc. 96, p. 64, t. xii. fig. 1.

Common among thickets, Chaloupe Bay, and in the central district. Also at the base of the Peak.

Distribution. Whole of the tropical world. Very common in Brazil.

Sterculia fœtida, *L.*

There were one or two fine trees of this plant in the gardens in the village.

GERANIACEÆ.

Oxalis Noronhæ, *Hook. Ic. Pl.* xiv. p. 21, t. 1226; *Hemsl. Bot. 'Challenger,' Exped.* pt. ii. *Atlant. Isl.* p. 14.

This plant is common on nearly all the larger islands, Ilha dos Ratos, Sella Giueta, and the main island, wherever it can find sufficient protection from the wind. It was originally described from imperfect material collected by Darwin and Moseley; and is, as far as at present known, peculiar to this group of islands. I examined the plants with some care, and am therefore able to add some further notes concerning it. It is a shrub of from 1 to 6 feet in height, attaining its greatest dimensious in the Sapate woods, where it grows freely intermingled with *Jacquinia armillaris*, *Palicourea*, and other shrubs. The stem is never more than 2 inches thick, and covered with a smooth brown bark. The branches slender, rather stiff and erect. The leaves are very slightly sensitive, light dull green, and, like almost the whole plant, pleasantly acid. The flowers are large and bright yellow, opening in the early morning and closing up as the sun becomes hot, so that the flower looks again like a bud. There are two forms of the flower borne on different bushes, differing in the length of the styles. The commonest is the brevistyled form. In this the inner whorl of stamens is long enough to reach to the mouth of the corolla, while the outer row, which are thicker at the base, reach only about halfway. The bright green stigmas project between the upper stamens at a distance of about halfway between the anthers of the upper and lower whorl. In the

long-styled form the stigmas are raised to the level of the corolla-mouth, while the long whorl of stamens is considerably shorter. At the base of the outer stamens glands secrete nectar, which is sought by a small black bee (*Andrena*, sp.), which is no doubt the fertilizer of the plant; for I never saw any other insect of sufficient size at the flowers.

The capsule is explosive.

Oxalis sylvicola, n. sp. (Plate II. figs. 3, 4.)

Herba annua, erecta gracilis semipedalis raro ramosa, radice fibrosa. Caulis tenuis pubescens. Folia trifoliata; petioli gracillimi pubescentes ferme unciam longi, erecto-patuli; foliola late ovata obtusa brevissime petiolulata, $\frac{1}{2}$ unciam longa, $\frac{3}{8}$ unciam lata, parce pubescentia præsertim ad bases; stipulæ nullæ. Flores parvi pulchre flavi, 3–4 in apice pedunculi tenuis pubescentis $1\frac{1}{2}$-uncialis erecti, demum fructu maturante deflexi. Bracteæ minutæ setaceæ. Pedicelli longiores, $\frac{1}{8}$-unciales. Calyx pubescens, sepala 5 lanceolata acuminata angusta pubescentia vix $\frac{1}{8}$-unciales. Petala obovata unguiculata obtusa vel flava $\frac{5}{16}$ unciam longa. Stamina 10, interiora longiora, filamentis pubescentibus, exteriora brevia glabra; antheræ ovoideæ. Pistilla 5, quam stamina interiora breviora, glabra; styli breves, excurvi; stigmata capitata. Capsula quam sepala brevior pentagona. Semina pauca in loculo quoque, magna castanea oblonga transversim rugosa.

I have only seen as yet the short-styled form, which perhaps is the only form that exists, as is the case in *O. stricta* and some others; but these possess long-styled flowers only. The flower-peduncle is at first erect; but as the fruit ripens it becomes deflexed till it forms an acute angle with the stem. The capsule is very short and pentagonal, and the seeds are unusually large for the capsule.

This pretty little *Oxalis* was found only at one spot in the thickest part of the Sapate, at almost the furthest accessible point. There was only a small quantity of it growing among the bushes by a woodcutter's path.

SAPINDACEÆ.

Schmidelia insulana, n. sp.

Frutex ramosus magnus foliosus cortice griseo verruculoso. Folia

trifoliolata glabra polita læte viridia coriacea; petioli $1\frac{1}{2}$-unciales foliola subsimilia ovata utrinque acuminata acuta, ferme integra, marginibus obscure sinuatis, lamina 3 uncias longa, $1\frac{1}{2}$ unciam lata. Racemi simplices in axillis foliorum superiorum, nutantes, $1\frac{1}{2}$ unciam longi, rhachide pubescenti, basi nudi. Flores laxi parvi virides, pedicellis brevibus pubescentibus. Bracteæ brevissimæ ovatæ obtusæ.—♂ flores. Sepala 4, inæqualia lata ovata rotundata obtusa, margine pubescenti. Petala sepalis subæqualia, unguiculata, obcuneata, truncata, pubescentia. Stamina 8; filamenta quam sepala paullo longiora, basi incrassata pubescenti, antheræ ovoideæ. Discus rotundatus inæquilaterus, marginibus incrassatis involutis.

This large bushy shrub was very plentiful in the Sapate, especially in the more open spots. Its leaves are bright green and somewhat hard and polished. The flowers are small and green, borne on short racemes in the upper axils. The plant only commenced to flower shortly before we left the island; and although we sought carefully and took specimens from numerous bushes, we were unable to find any female flowers; nor is there the least trace of a pistil visible upon the disk in the male flowers.

CARDIOSPERMUM HALICACABUM, *L. Sp. Pl.* ed. 1, p. 366.

Common on the main island in the thickets, especially in the Sepate. Baskets are made of its stems. Flowers white, very sweet-scented.

Distribution. Most tropical countries.

AMPELIDEÆ.

VITIS VINIFERA, *L. Sp. Pl.* ed. 1, p. 202.

There are a few Vines cultivated here which produce good fruit, but not in large quantity.

V. SICYOIDES, *Baker in Mart. Fl. Bras.* xiv. 2. p. 202.—Cissus sicyoides, *L. Sp. Pl.* ed. 2, p. 170.

Abundant, climbing over the bushes in the main island in the more open parts. In a small wood of Burra in the centre of the island the stems of large size hung down from the trees like lianes. The flowers are cream-coloured; the berries black and sweet. In the thickets of the Sapate we frequently found the remarkable monstrous tufts looking like some parasitic plant on

the vine-stem, which were called by Presl *Spondylantha aphylla* (Rel. Hænk. ii. 35. t. 53).

ANACARDIACEÆ.

SPONDIAS PURPUREA, *L. Sp. Pl.* ed. 2, p. 613; *Jacq. Amer.* t. 131.

There are a number of trees of what seems to be this species not only in the gardens, but also apparently wild in the Sapate, perhaps planted there by birds. Many of the trees were quite bare of leaves during our visit, and neither fruit nor flowers were seen. It is known as "Caja."

MANGIFERA INDICA, *L. Sp. Pl.* ed. 1, p. 200.

There are a few trees of the Mango scattered about the island.

ANACARDIUM OCCIDENTALE, *L. Sp. Pl.* ed. 1, p. 383; *Griseb. Fl. Brit. W. Ind.* p. 176.

Is abundant in many spots in the central, cultivated districts, growing often in the maize-fields, and also in the Sapate. It does not appear to be indigenous here, as it is doubtless in Pernambuco.

COMBRETACEÆ.

TERMINALIA CATAPPA, *L. Mant.* p. 519.

There are a few trees of this plant scattered over the island, it having been introduced.

LAGUNCULARIA RACEMOSA, *Gaertn. f. Fruct.* iii. t. 217; *Eichl. in Mart. Fl. Bras.* xiv. 2. p. 101.

The largest stream, the one at Suesta, which flows into the sea at Tobacco Point, had a thick fringe of this Mangrove along its banks. The trees were about 20 feet high, a good deal taller than they are in the mangrove-swamps on the mainland.

Distribution. All the coasts of Tropical America and Western Africa.

COMBRETUM, § TERMINALIOPSIS, n. sect.

Frutex ramosus *dioicus,* foliis oppositis coriaceis ovatis obtusis exstipulatis, spicis axillaribus gracilibus, floribus minimis globosis viridibus pubescentibus sessilibus, sepalis connatis epigynis intus ac extus pubescentibus, petalis nullis.

COMBRETUM RUPICOLUM, n. sp.

Frutex dioicus ramosus. Folia opposita ovata rotundata coriacea glabra obtusa, 3 uncias longa, 2 uncias lata, petiolo crasso ¼-unciali. Stipulæ nullæ. Racemi 2–3-unciales in axillis foliorum basibus breviter nudis, rhachide pubescenti. Flores parvi copiosi virides sessiles pubescentes. Bracteæ minutæ lanceolatæ pubescentes, ovariis æquilongæ. Sepala 4, connata, apicibus rotundatis obtusis extus et intus pubescentia. Petala nulla. Stylus cylindricus integer sepala paullo superans, apice curvo; stigma parvum integrum. Ovarium quadratum pubescens, ovulum singulum erectum.

This shrub grows on the basaltic boulders of the East Hills, about 600 feet above sea-level. It had dark green opposite leaves and slender racemes of green flowers. It was only found in flower just previous to our departure; and we were unable to find any male flowers.

It is probable that it would constitute a new genus of Combretaceæ; but in the absence of male flowers and fruit, I think it unadvisable to found a new genus on our material. One or two Combretums show a tendency to become diœcious; but this is the only known truly diœcious species. The habit is somewhat that of a *Terminalia*; but the opposite leaves show it to be really nearer to *Combretum*.

LEGUMINOSÆ.

§ GENISTEÆ.

CROTALARIA STRIATA, *DC. Prodr.* ii. p. 131; *Benth. in Mart. Fl. Bras.* xv. 1. p. 26.

Common amongst the fodder-plants in the central district.

Distribution. Warm parts of the whole world. It is abundant in waste ground round Pernambuco.

§ GALEGEÆ.

INDIGOFERA ANIL, *L. Mant.* p. 272; *Vell. Fl. Flum.* vii. t. 20; *Benth. in Mart. Fl. Bras.* xv. 1. p. 41.

Not rare along the pathway through the Sapate, and by the edges of the maize-fields at Leao. Widely distributed all over the world, and probably introduced here by man.

TEPHROSIA CINEREA, var. LITTORALIS, *Benth. in Mart. Fl. Bras.* xv. 1. p. 48.—Vicia littoralis, *Jacq. Amer.* t. 124.

Common in the bushes at Chaloupe Bay and on the sand-hills at Fort San Antonio. Also common in Rat Island. The flowers are usually pink; but white-flowered specimens were found on Rat Island. Like most of the genus, it kills fish when put into the water in which they live. Bunches of the plant with long roots were bruised with a club and stirred in a rock-pool. Presently the fish concealed in the coral clefts began to dart in and out, and soon coming out entirely, went into convulsions, and finally died. We obtained many species in this way, which would otherwise have been difficult to obtain.

Distribution. All warm parts of South America from Mexico southwards.

SESBANIA ÆGYPTIACA, *Pers.*

There were two or three trees of this beautiful plant loaded with flowers in the convicts' gardens.

§ HEDYSAREÆ.

ÆSCHYNOMENE HISPIDULA, *H. B. K. Nov. Gen. et Sp.* vi. p. 531; *Benth. in Mart. Fl. Bras.* xv. 1. p. 59.

This shrubby plant was very common in the central district of the main island, and on the north side of Rat Island were dense beds of it covering the slopes towards the sea to the exclusion of other plants. The flowers are yellow.

Distribution. Central America to Minas Geraes and Lima.

ZORNIA DIPHYLLA, *Pers. Syn. Pl.* ii. p. 318, var. RETICULATA GLABRA, *Benth. in Mart. Fl. Bras.* xv. 1. p. 81.

Common on the turf of the eastern promontory beyond Fort San Antonio; also at Tobacco Point; and a slightly large-leaved form among the stones on the road above the Residency garden.

Var. ELATIOR, *Benth. l. c.*

Among long grass in Chaloupe Bay.

Distribution. A common plant of world-wide distribution, very abundant in Brazil. It is very variable; but all the specimens collected in Fernando Noronha belong to the glabrous group.

DESMODIUM TRIFLORUM, *DC. Prodr.* ii. p. 334; *Benth. in Mart. Fl. Bras.* xv. 1. p. 95, t. xxvi.—Sagotia triflora, *Duchass. & Walp. in Linnæa,* xxiii. p. 738.—Nicolsonia reptans, *Meissn. in Linnæa,* xxi. p. 260.

Turfy spots on the promontory between Chaloupe Bay and San Antonio Bay; on the top of the cliffs opposite the Frade; and very abundant and tall in Leao Bay, behind the Fort.

The minute flowers are of intense deep blue, rarely white.

Distribution. East Indies, and perhaps introduced thence into South America.

Desmodium (§ Nicolsonia) barbatum, *Benth. in Miq. Pl. Jungh.* i. p. 224, *et in Mart. Fl. Bras.* xv. 1. p. 95.—Hedysarum barbatum, *L. Sp. Pl.* p. 1055.

On the sides of Morro branco, and also on the eastern slope of Look-out Hill.

In both of these localities the soil was phonolite altered by contact with basalt; and it was never found except on this rock. Flowers brilliant blue.

Distribution. East Indies; also all parts of tropical America.

D. spirale, *DC. Prodr.* ii. p. 332.

Very common among thickets in Chaloupe Bay and the entrance to the Sapate. Also plentiful on Rat Island. Flowers white or yellow. Obtained also by Moseley.

D. incanum, *DC. Prodr.* ii. p. 332; *Benth. in Mart. Fl. Bras.* xv. 1. p. 98.

On the top of the cliff between Chaloupe Bay and San Antonio Bay. Also common along the path through the Sapate. Flowers rose-pink.

Distribution. All tropical countries.

§ Vicieæ.

Abrus precatorius, *Linn. Syst.* ed. xii. p. 472.

Very common on the Sapate, and also on the cliffs between Chaloupe Bay and San Antonio Bay.

Distribution. Throughout the tropics generally.

§ Phaseoleæ.

Erythrina aurantiaca, n. sp. (Plate I.)

Arbor 20–30-pedalis, diametro 9–12 uncias. Cortex lævis, atro-brunneus. Coma patula ramosa. Rami juvenes atri pulverulento-tomentosi, spinis brevibus conicis atris nonnunquam bifidis tecti. Folia trifoliolata, glauca, vetusta glabra, ad 7 uncias longa,

petiolis spinosis, foliolo terminali ovato subtriangulari obtuso, $3\frac{1}{2}$ uncias lato, 3 uncias longo, lateralibus inæquilateris ovato triangularibus, petiolulis $\frac{1}{4}$-uncialibus, folia juvenilia minora pulverulenti-tomentosa. Flores in racemis subterminalibus brevibus speciosi iis *E. glaucæ* subsimiles, minores. Calyx bilabiata pulverulenta, $\frac{3}{4}$ unicam longa, labio inferiore apice bifido quam superior longiore. Vexillum unguiculatum ovatum obtusum patulum, $1\frac{1}{2}$ uncias longum, $1\frac{1}{2}$ uncias latum, aurantiacum, venis viridibus. Alæ breves, auriculiformes, $\frac{1}{2}$-unciales, virides, rubro-marginatæ. Carina brevis viridis alis subsimilis subæqualis. Stamina 10, basi longiusculi connati kermosina, biuncialia. Pistillum androœcio subæquale. Ovarium pubescens. Stylus gracilis roseus. Stigma rotundata parva viridia. Legumen 3–4-uncialis, apice longe acuminata 1–2-spermum. Semen $\frac{1}{2}$-uncialis oblongum, dorso carinati, atrum politum, circa hilum coccineum.

Main island, scattered bushes near the village and in the Sapate. One full-grown tree in the cocoa-nut plantation at Sueste. It also occurs at Sella Giueta.

This very interesting tree is called "Mulungu" by the inhabitants of the island, which name is also applied to *Erythrina Mulungu*, Mart., quite a different species, of which we saw a single fine-tree at Iguarassa near Pernambuco. It is scrupulously cut down by the convict woodcutters under the direction of the Governor, as it is stated that if rafts are made of it they become water-logged and sink in open sea in three days. This is no doubt the tree called *Erythrina exaltata* by Webster in the Voyage of the 'Chanticleer' as cited on p. 18, which, he says, is the largest tree in the island; and it is also, I believe, the plant intended by Moseley, Linn. Journ. Soc. Bot. xiv. p. 360. "I saw several specimens of a tree with rounded leaves of a bluish green and stout thorns: it had a Euphorbiaceous look. . . . One of the trees was about 20 feet high and 9 inches in diameter of trunk." Now, I believe, there is only one tree of it left of any size in the islands, and that is in the cocoa-nut grove at Sueste; and the young plants scattered over the wooded districts and thickets in the main island, and also Sella Giueta, do not show any signs of bearing flowers, as they are too young. The tree which Moseley saw near the village is cut down, only a bush remaining. It so seldom flowers, that I could not at first elicit from the convicts what the colour of the flowers was; and under the present regime it will, I fear, soon be extinct. The tree at Sueste is about 30 feet

high, with a spreading head of branches, which, as it was in flower at our visit, bore then only a few leaves on the extremity of the branches. The bark in younger plants is dark green, and covered with strong blackthorn; but in the lower part of the older tree it was brown and bare of the thorns. It is quite smooth, and not cut up into cracks, as is the case in *Erythrina Mulungu*. The full-sized leaves are glabrous and of a greyish green, the younger ones covered with a mealy pubescence which becomes rufous. The flowers are borne on short racemes, of about a dozen, on the ends of the branches. They somewhat resemble at first sight those of *E. glauca*, Willd., but are a good deal smaller. The standard is broad and reflexed, of a dull orange-colour, with greenish veins. The alæ and keel are polished green with red edges, and the bright crimson andrœcium contrasts beautifully with the orange standard. The buds are covered with a reddish tomentum like the young branches. We were unable to obtain fruits at the time of our visit; but by the kindness of the Director of the island we received a good series of both fruits and seeds. The pods contain one or two seeds, entirely black, except for a red band round the hilum; they are oblong, smooth, and polished. With the specimens came notes, saying that "it is said that three or four unbarked Mulungu-seeds, being ground and mixed with food, will kill any dog or cat that eats it; and consequently these seeds are never found eaten by mice. It is propagated by cuttings. And a warm infusion of the inner part of the bark is used in toothache."

Erythrina, sp.

Among the fruits and seeds sent after our return to England by the Director of the island were fruits and seeds of another species of *Erythrina* from Leao, with a note that this species very closely resembled the preceding in foliage and habit, but that the seeds were different. The pod is rather longer and broader, and less abruptly dilated where the seeds occur. The seeds are a little longer and more pointed, *i. e.* less oblong with no distinct keel, and entirely red except the hilum. This is the rosy Mulungu, "Mulungu vermelho" of the inhabitants. The material received is insufficient for determination as to species.

Mucuna urens, *DC. Prodr.* ii. p. 405; *Benth. in Mart. Fl. Bras.* xv. 1. p. 169, t. xlvi. 1.

We obtained two seeds of this plant among seaweed &c. drifted on the shores of Sueste Bay; but the species has not established itself here yet. It is very common on the mainland, and was well known to the convicts, who all agreed that it did not belong to the island. This is well known as a drift-seed (Hemsley, 'Chall.' Rep. Bot., Juan. Fernand. &c. p. 299).

Canavalia obtusifolia, *DC. Prodr.* ii. p. 404; *Benth. in Mart. Fl. Bras.* xv. 1. p. 178, t. xlviii.—Dolichos obtusifolius, *Lam. Encyc.* ii. p. 295.

Plentiful on Rat Island on both sides, and on the main island at the base of the Peak and at Tobacco Point and beyond Morro branco. It grows only over the fallen boulders of basalt a little way above high-water mark, mingled with *Philoxerus vermicularis.* It is a large plant with showy crimson flowers. Like the preceding, this is a plant of wide distribution, the leaves of which are carried about by ocean-currents.

Phaseolus lunatus, *L. Sp. Pl.* i. p. 1016; *Benth. in Mart. Fl. Bras.* xv. 1. p. 181.—P. bipunctatus, *Jacq. Hort. Vindob.* t. 100.

Common, and apparently cultivated in the island. It occurred in many parts of the central district, and also at the summits of some of the more uncultivated hills, such as Morro branco.

Distribution. All warmer parts of the world.

P. peduncularis, *H. B. K. Nov. Gen. et Sp.* vi. p. 447; *Benth. in Mart. Fl. Bras.* xv. 1. p. 184.

One of the most abundant plants in the main island, and equally common on St. Michael's Mount and on Rat Island, covering extensive tracts of country.

Distribution. Central America and North Brazil.

§ Bauhinieæ.

Bauhinia forficata, *Link.*

"Mororo." One or two trees occurred in the village, introduced as timber-plants. The wood is said to be so hard that only the best tools will cut it; and it is thus used as a test for axes and scythes.

Swartzia pinnata, *Willd.*?

Webster, in his account of the island, mentions *Swartzia pennata* as an ornamental plant, and sweet-scented in the evening. We saw nothing answering to his account; and it was possibly the true *S. pinnata*, Willd., introduced in cultivation.

Cajanus indicus, *Spreng. Syst.* iii. p. 248; *Lindl. Bot. Reg.* (1845), t. 31.

Several large plants near the village on the west side and in the sugar-cane fields in the central district. It is used as medicine, and was no doubt introduced intentionally.

Rhynchosia minima, *DC. Prodr.* ii. p. 385; *Benth. in Mart. Fl. Bras.* xv. 1. p. 204.

Common on the turf at the extreme eastern promontory at San Antonio Bay, and also at Tobacco Point.

Distribution. All warm countries.

§ Cæsalpinieæ.

Cassia Tora, *L. Sp. Pl.* p. 538; *Benth. in Mart. Fl. Bras.* xv. 2. p. 115.

Very common in the central district, forming a good fodder for the animals; and perhaps introduced for that purpose.

Distribution. All warm countries.

C. occidentalis, *L. Sp. Pl.* p. 539; *Benth. in Mart. Fl. Bras.* xv. 2. p. 113.

Common in the central district, and growing with the last species. The seeds are used to make a kind of coffee with some medicinal properties. The pods are collected and sold in the market tied up in small bundles for this purpose.

Distribution. All warm countries.

§ Mimoseæ.

Albizzia Lebbek, *Benth. in Hook. Journ. Bot.* iii. p. 87.

One or two trees occur in the gardens in the village. It is often grown in Pernambuco. It is called "Tamanqueira" because its wood is used to make wooden shoes of.

Acacia Farnesiana, *Willd. Sp. Pl.* iv. p. 1083.

There are numerous bushes of this plant on the shore below the village near the hospital, and also close to Fort San Antonio,

and in thickets in the central district and at Sambaquichaba. It is known as "Coronha Christi" and "Espongeira;" and the pods are used in making ink with the aid of iron; a gum is also extracted by boiling. It is a plant of world-wide distribution, and probably intentionally planted.

MYRTACEÆ.

Psidium Guyava, *Raddi*, and Jambosa vulgaris, *DC.*

Both are in cultivation here, the former fruiting abundantly.

LYTHRARIEÆ.

Ammannia latifolia, *L. Sp. Pl.* i. p. 174; *Koehne in Mart. Fl. Bras.* xiii. 2. p. 206.

Plentiful in one swampy spot in the central district, growing with *Paspalum brizoides*, *Jussieua*, and other marsh-plants.

Distribution. All warm parts of America.

ONAGRARIEÆ.

Jussieua linifolia, *Vahl, Eclog.* ii. p. 31; *DC. Prodr.* iii. p. 55; *Micheli in Mart. Fl. Bras.* iii. p. 163, t. xxxiii.—J. acuminata, *Sw. Fl. Ind. Occ.* p. 245.

Very common in the central districts, on the damp clayey soil. The flowers are bright yellow. The leaves seem a little broader than usual. Obtained also by Moseley.

Distribution. Cosmopolitan. In Brazil it seems to be especially common in the north-eastern district, Para, Amazonas, Goyaz, and Pernambuco.

PAPAYACEÆ.

Carica Papaya, *L.*

The Papaw is very largely cultivated, and its seeds apparently being carried about by birds, it is often to be seen in places where it appears to be quite wild. It is a very conspicuous feature in the scenery. The fruit is pyriform, and hangs down on the ends of the long peduncles; it is remarkably good and cheap. The rats are very fond of it, and often climb trees to eat it. Near the village are several male trees which bear monœcious flowers, and can often be seen in fruit.

CUCURBITACEÆ.

Luffa cylindrica, *M. Roem. Syn.* fasc. 2, p. 63; *Cogn. in DC. Monogr.* iii. p. 456.

This is constantly cultivated in the gardens, being allowed to grow on the hedges and walls. The fibrous network is used as wadding for guns under the name of "Buchu."

Luffa purgans, *Mart. Syst. Mat. Med. Bras.* p. 81; *Naud. Ann. Sc. Nat.* sér. 4 xii. p. 125.—L. operculata, *Cogn. in Mart. Fl. Bras.* vi. 6. p. 11.

"Cabacinha." Used here as a purge and emetic; but a dangerous drug, as persons have been killed by the use of it.

[Momordica Charantia, *L. Sp. Pl.* ed. i. 1009.

Rat Island; see p. 3.

Distribution. All tropical countries.]

Cucumis Melo, *L. Sp.* ed. 1, p. 101; *Cogn. in DC. Monogr.* iii. p. 482.

The Melon is very carefully cultivated, and produces exceedingly good fruit, far better than that of the mainland.

Citrullus vulgaris, *Schrad. in Linnæa*, xii. p. 412; *Cogn. l. c.* p. 588.

This is also very productive here. I found a plant in which all the flowers were converted into leaf-buds.

Cucurbita Pepo, *L. Sp. Pl.* ed. 1, p. 1010; *Cogn. in DC. Monogr.* iii. p. 545.

This is the most commonly cultivated of the three last-named. All these Melons, except *Luffa*, grow on all the open spaces, climbing up to the top of the hills, and are often to be found mixed up with endemic and other indigenous plants; so that it is at first difficult to see which is cultivated and which wild. None of these occur on any of the other islands except Rat Island, which was famed for its Melons in Webster's time. The rats destroy a great quantity of them.

Cayaponia Tajuja, *Cogn. in DC. Monogr.* iii. p. 772.—Bryonia Tajuja, *Vell. Fl. Flum.* x. t. 89.—Trianosperma Tajuja, *Mart. Syst. Med. Bras.* p. 80; *Naud. in Ann. Sc. Nat.* sér. 4, xvi. p. 192.

This was abundant on the Peak, growing mixed with *C. racemosa*, *Momordica*. The flowers are greenish, fruit orange. It is called "Tajuja" by the natives.

Distribution. Goyaz to Rio Grande do Sul.

CAYAPONIA RACEMOSA, *Cogn. in DC. Monogr.* iii. p. 768.—Bryonia racemosa, *Sw. Prodr.* p. 116.—Cionandra racemosa, *Griseb. Fl. Brit. W. Ind.* p. 286.—Trianosperma racemosa, *Griseb. Cat. Pl. Cub.* p. 112.

Common on the Peak and at Tangle Rock, and in the Sapate.

Distribution. A native of Mexico, the West Indies, and Guiana.

CERATOSANTHES ANGUSTILOBA, n. sp.

Dioica? caulis validulis, cirrhi longi graciles simplices. Folia trifoliolata, foliolis lateralibus inæqualiter bilobis, lobi angusti lineares lanceolatæ obtusi marginibus ciliatis; foliolo mediano integro anguste lineari-lanceolato acuto, 3 uncias longo, $\frac{1}{4}$ unciam lato. Pedunculi glabri validuli, 5-unciales. Racemi breves, masculi pauciflori, compacti. Flores virescentes parvi, masculi, tubus gracilis $\frac{3}{8}$ unciam longus. Sepala glabra ovata subacuta viridia; petala basi oblonga angusta, laciniis angustis linearibus, pubescentia, $\frac{1}{4}$ unciam longa. Antheræ oblongæ breves. Flores feminei et fructus non visi.

On the Peak, with other species.

This plant is easily distinguished from the rest of the genus by its narrow lobed leaves, with the lateral lobes again bilobed. The flowers also are very small in comparison at least with those of *C. trifoliolata*, the only species really near to it. It had a very unpleasant smell when bruised.

C. CUNEATA, n. sp.

Dioica, glabra, caules graciles striati, cirrhi simplices nec valde longi. Folia triloba glabra, foliola obcuneata apice dentata irregulariter, dentibus subacutis, 3 uncias longa, $1\frac{1}{2}$ uncias lata quo latissima. Pedunculi validuli 3-unciales, apice racemosi. Racemus circiter 12-florus. Flores albescentes, perianthio in utroque sexu simili. Tubus $\frac{1}{2}$ unciam longus. Sepala brevia, late ovata obtusa carnosula glabra. Petala 5 longa basi lata, lamina angusta obtusa longe bifida, pubescentia, extus septem nervia. Stamina oblonga brevia compacta, cohærentia. Flores feminei. Stylus longus ferme $\frac{1}{2}$-uncialis planus latus; stigmata 2, brevia acuta; staminodia duo parva ovata perianthio adnata, paullo supra stigmata. Bacca non visa.

On the Peak, with other species of Cucurbitaceæ.

This species is allied closely to *C. Hilariana*.

CERATOSANTHES RUPICOLA, n. sp.

Dioica, glabra, caules graciles striati, cirrhi longi simplices. Folia triloba, marginibus ciliatis, lobi profunde fissi nec omnino liberi, exteriores obliqui ovati angulati integri minute mucronati, 2 uncias longi, 1 unciam lati, petiolis $\frac{3}{4}$-uncialibus. Pedunculi 6-unciales, glabri, racemi breves $1\frac{1}{2}$-unciales. Flores masculi . . . albescentes, $1\frac{1}{2}$ unciam longi pedicellis inclusis; sepala 5 ovata brevia submucronata crassiuscula, extus pubescentia; petala basi oblonga, laciniis longis angustis obtusis, $\frac{1}{2}$-uncialia, extus pubescentia intus ad basin, costis elevatis 5. Stamina tubo adnata. Antheræ breves crassi, $\frac{1}{8}$ unciam longæ. Flores feminei et fructus non visi.

This plant only occurred scrambling over the basalt rocks of the East hills. It is allied to *C. trifoliolata*, Cogn., but distinct in its less deeply cut leaves and entire leaflets.

FICOIDEÆ.

SESUVIUM DISTYLUM, n. sp.

Herba prostrata læte virens, carnosa, ramis 6–12-uncialibus. Folia cuneata spathulata obtusa, exstipulata, basi scariosa vaginante, unciam longa, $\frac{1}{4}$ unciam lata. Flores albi singuli breviter pedicellati, $\frac{1}{4}$ unciam in diametro. Perianthium basi connatum, tubo brevi, segmenta tria exteriora lanceolata acuta, submucronata apice cucullata, interiora duo latiora ovata mucronata. Stamina plura quam perianthium breviora, filamenta complanata tenuia; antheræ ovoideæ. Ovarium breve conicum obtusum, apice depresso. Styli duo graciles quam perianthium multo breviores. Semina plura nigra reniformia.

Rat Island, growing only within the spray of the blowhole at the south-west corner; abundant there, but seen nowhere else. The soil at this spot is reef-rock covered with guano in parts. The plant grows in the holes formed by the weathering of the rock, and makes bright green patches visible for some distance.

The species is very near *S. portulacastrum*, L.; but I believe it to be quite distinct in the colour of the flowers, which are not even tinted with pink or purple, and in the number of styles, never less than three in *S. portulacastrum*; but in this species there are but two, and these much shorter than in the latter plant.

CACTACEÆ.

CEREUS INSULARIS, *Hemsl. Bot. 'Chall.' Exp., Atlantic Isles*, p. 16, t. xiv.

This was described and figured from material brought by the 'Challenger' expedition; but as the description is incomplete in some respects and inaccurate in others, owing to deficiency of material, I append an emended description.

Planta valida, ramis 6–12-pedalibus, erectis vel pendulis, apicibus recurvis, 1–1½ uncias diametro, costis obtusis sæpissime 7, ¼ unciam altis continuis, areolæ pulvinatæ, ¼ unciam dissita lanugine albo parvo; spinæ radiatæ ochreæ 12–15, inæquales pungentes, longiores, unciam longæ. Flores nocturni, 5–6 uncias longi, 2 uncias in diametro, erecti, amœnissime odori, ochroleuci. Calycis tubus 3-uncialis, vix ¼ unciam in diametro, viridis, squamis paucis rufescentibus lanceolatis acuminatis. Sepala lanceolata acuta pauciseriata, rubro-viridia, longiora uncialia. Petala ochroleuca ferme alba tenuia late lanceolata obtusa, apicibus minute fimbriatis, quam sepala paullo breviora. Stamina erecta copiosa, quam petala breviora; interiora multi breviora, filamenta alba apice attenuata; antheræ oblongæ, ⅛-unciales, flavi. Stylus validulus 5-uncialis. Stigmata ¼-unciam longa, 7–11, subacuta, viridia. Ovarium viride ¼-unciale multiovulata. Fructus magnus 4 uncias longus, 3 uncias latus, oblongus obtusus, kermesinus, albo-pruinosus. Semina parva nigra.

This is very common on Rat Island, Booby Isle, San José, Sella Giueta, as well as on the main island, and is one of the most conspicuous plants. It frequently hangs down over the cliffs, quite covering them; but also forms thickets in open dry spots, and also grows even in the dense thickets of the Sapate. Here there was a woodland form, which differed in some respects from the common type, and may be the *Cactus quadrangularis* of Webster. It has more slender dark green stems less than an inch in diameter, with five ridges only and very short weak thorns, the largest of which were only half an inch long. No signs of fruit or flower were found on this form; but I have little doubt that it is a wood form of the common species. On two occasions fasciated branches were found in the dense thicket at the summit of Tangle Rock.

The flower opens widely only at about 10 o'clock at night, at which time it is very sweetly scented. It is erect, of a pale cream colour within, and not yellow as described in the 'Challenger' Report. The sepals, however, are reddish green, and the calyx-tube and ovary bright green. The flower closes again before dawn, and apparently does not reopen during the following night. The stamens are very numerous, white, with yellow anthers, and erect, scattered over the corolla-tube, the inner ones much shorter than the outer; all are a little shorter than the petals. The styles lie outside the staminal ring, even when the flower is erect. The stigmas are short and thick, variable in number, green or greenish yellow, sometimes, but rarely, branched. They never appeared hooked as figured in the 'Challenger' Report. The fruit is large when fully developed, of a dark rose-pink, with a bloom on the outside. The placentæ are white and sweetish in taste. The seeds numerous and black.

The plant seems to be quite irregular in its periods of fruiting and flowering, as it was possible to obtain flowers, fruit, and young buds all at once on the same spot. The common name for it is "Chique chique."

GAMOPETALÆ.

RUBIACEÆ.

Spermacoce parviflora, *Hemsl.*, *Biolog. Centr.-Amer.*, *Botany*, ii. p. 59.—Borreria parviflora, *W. Mey. Fl. Essequib.* p. 81, t. i.

Common on the Peak and in the open spaces at Tangle Rock and elsewhere, covering large tracts with a tangled mass of stems, often knee-deep. The flowers are white.

Distribution. All Tropical America.

Guettarda Leai, n. sp.

Frutex humilis, ramis brevibus, undique foliosus. Folia ovalia elliptica obtusa, pagina superiore glabra, inferiore glauco pubescens, costis prominulis, lamina ferme 4 uncias longa, $2\frac{1}{4}$ lata, petiolus puberulus $1\frac{1}{2}$ uncias longus. Pedunculi folia vix superantes, puberuli. Flores circa 10 parvi albi pubescentes. Bracteæ lanceolatæ acuminatæ, calyces vix æquantes. Calyx pubescens, truncatus, unidentatus, $\frac{1}{8}$ unciam longus. Corolla brevis, $\frac{1}{2}$ unciam

longa, gracilis sericeo-pubescens alba. Lobi rotundati breves, interne glabri. Stamina 5 . . . . antheræ dorsifixæ multo longiores quam latæ, os tubi non superantes, ferme omnino sessiles in corolla. Stylus stamina non superans pubescens, basi incrassata. Stigma rotundatum clavatum. Drupa parva globosa testaceo-puberula, calyce coronata.

This shrub is distinguished from all the other Brazilian species by its small flowers and large leaves. The foliage resembles that of *Guettarda viburnoides*; but the flowers are small, straight, and regular, like those of *G. angelica*, which also it resembles in fruit. It is a low leafy shrub, only growing in the denser parts of the wooded Cape Placellière. Very few plants were seen, and some of these not in flower or fruit. The flowers are white, about a dozen together in the cyme; the stamens as nearly as possible sessile on the corolla-tube, and the stigma reaching to the level of the top of the anthers.

I have much pleasure in associating with it the name of the Rev. T. S. Lea, who first found it.

Palicourea insularis, n. sp.

Frutex gracilis 10–12-pedalis, undique foliosus. Folia coriacea, lanceolata, subobtusa densa, lamina 3 uncias longa, $1\frac{1}{2}$ uncias lata; petiolus $\frac{1}{4}$-uncialis. Stipulæ breves amplexicaules unidentatæ. Inflorescentia axillaris. Panicula pauciflora patula vix triuncialis. Flores $\frac{3}{8}$-unciales, albi, pedicellis $\frac{1}{2}$-uncialibus patulis. Calyx poculiformis dentibus 5 parvis, subobtusis, viridis. Corolla 5-partita, laciniis loratis obtusis recurvis. Stamina quam petala breviora 5, libera ad basin; antheræ lineares acuminatæ non appendiculatæ. Stylus petala superans. Stigma clavatum obtusum viride integrum. Drupa viridis, 5-angulata, 5 loculis.

Main island, in the Sapate woods, only a few bushes at one spot.

COMPOSITÆ.

Blainvillea rhomboidea, *Cass. in Dict. Sc. Nat.* xxix. p. 494; *DC. Prodr.* v. p. 492; *Oliver, Fl. Trop. Afr.* iii. p. 375.

Central district in damp spots. Also a garden-weed.

Distribution. Brazil, from Pernambuco to Rio de Janeiro; also Tropical Africa.

Eclipta erecta, *L. Mant.* p. 286; *DC. Prodr.* v. p. 490.—E. alba, *Hassk. Pl. Jav. Rar.* p. 528.

Base of Peak; also below Tangle Rock in damp places.

Distribution. All warm and tropical countries.

Aspilia Ramagii, n. sp.

Suffrutex humilis, ramosus, pubescens, subpedalis. Folia opposita, ovata acuta, lamina in petiolo decurrente, margine minute serrato, scabra, venis et petiolo hispidis, venis dorso prominulis tribus. Lamina ferme 3 uncias longa, $1\frac{1}{2}$ uncias lata. Petiolus $\frac{3}{4}$ unciam longa. Capitula in pedunculis 1–3-uncialibus hispidis vix unciam in diametro. Involucrum 2-seriatum, seriei externa lanceolata hispida, interiora oblonga obtusa apice minute pubescenti, scariosa. Flores radii flavi, lamina lata oblonga apice bifidi? 5 millim. lati, 15 longi, plurivenia; tubus brevis. Stylus teres; stigmata gracilia subteretia. Flores tubulosi, plures, flavi. Calycis lobi breves, obtusi. Corolla 5-partita, apicibus acutis, marginibus incrassatis, dorso pubescentia; stamina libera, filamentis gracilibus. Antheræ elongatæ atræ, lineares, connectivo apiculato, corollam superantes. Stylus teres; stigmata crassiuscula, apice abrupte acuminata.

East Hills.

I am pleased to associate this plant with the name of Mr. G. A. Ramage, who found it on the summit of the Eastern Hills, growing among the broken basaltic boulders. The leaves, when crushed, were deliciously aromatic; but the scent disappeared on drying. The plant is a small half-shrub, with rough scabrid foliage. The blade of the leaf is decurrent on the petiole, so that the three prominent veins on the back of the leaf do not arise from the base of the lamina. The flowers are bright yellow.

Ageratum conyzoides, *L. Sp. Pl.* p. 1175; *DC. Prodr.* v. p. 108; *Baker in Mart. Fl. Bras.* vi. 2. p. 194.

Exceedingly common all over the central district; but not found on any of the other islands. It is the commonest species of Compositæ here, covering large tracts of ground.

Distribution. World-wide.

Acanthospermum hispidum, *DC. Prodr.* v. p. 522.

There were a number of bushes of this plant in and about the village. It seems usually to occur in waste spots and sandy shores in various parts of South America, including Brazil.

PLUMBAGINEÆ.

Plumbago scandens, *L. Sp. Pl.* ed. i. p. 215; *H. B. K. Nov. Gen. et Sp.* ii. p. 220; *J. A. Schmidt in Mart. Fl. Bras.* vi. p. 166, t. xlvi. fig. 2.—P. occidentalis, *Sweet, Hort. Brit.* ed. 3, p. 565.

There was a large patch or two on the sand-hills at San Antonio, and also among the bushes at the entrance to the Sapate near the path.

Distribution. South America, from Yucatan to Rio de Janeiro. It is common in the woods at Pernambuco.

MYRSINEÆ.

Jacquinia armillaris, *Jacq. Amer.* p. 53, t. 39; *Linn. Sp. Pl.* ed. 2, p. 272; *Miq. in Mart. Fl. Bras.* x. p. 281.

One of the commonest bushes in the Sapate, attaining a height of 8 or 9 feet. Stunted bushes occurred also on Morro branco, and on the hillside at Tangle Bay. The fruit is a rather sweet cherry-red berry. The flowers are pale flesh-colour.

Distribution. West Indies and as far south as Bahia.

SAPOTACEÆ.

Bumelia fragrans, n. sp.

Arbor ramosus ad 20-pedalis, spinosus; ramis junioribus ferrugineo-pubescentibus. Folia juniora cuneata spathulata obtusa, $\frac{3}{4}$ unciam longa, $\frac{3}{8}$ unciam lata, seniora oblonga obovata obtusa, unciam longa, $\frac{3}{4}$ unciam lata, omnia atro-viridia, lucida, dorso pubescentia. Flores circiter 20 vel pauciores in glomerulis pallide virides, amœnissime odores, pedicellis vix $\frac{1}{4}$-unciales argenteo-sericeis. Sepala 5, ovata sericea integra. Petala exteriora 5 late ovata obtusa glabra, marginibus minute crenulatis; interiora 10 angustata lanceolata breviora, margine dentato. Stamina 5, petala superantia; antheræ angustæ oblongæ, extrorsæ, filamentis crassiusculis; staminodia 5, petalis interioribus majora, lanceolata tenuia marginibus denticulatis, connectiva crassa. Stylus acuminatus subacutus, basi crassa. Ovarium pilis circumcinctum. Drupa viridis oblonga, ferme $\frac{1}{2}$ unciam longa. Semen durissimum atrum lucidum.

This plant grows in the Sapate as a thorny compact shrub, or in more open spots as a large bushy tree with the habit of

a blackthorn. It is very thorny, the spines about half an inch long. The leaves are dark green, somewhat shiny and pubescent on the back; on the younger bushes cuneate, and broader and more rounded on the bigger trees. The flowers are green and inconspicuous, but most deliciously scented, and, being very profuse, the whole tree is strongly perfumed when in flower. The flowers of this species and, as far as one can make out from dried specimens, those of the other two Brazilian species are proterogynous. The berries are oval and green, like very small unripe sloes. The plant is called "Quichaba" by the inhabitants, which name is referred by Miers, in his manuscript list of woods of Brazil preserved in the British Museum, to some species of Sapotaceous plant unknown to him, but which was probably the common *Bumelia obtusifolia*. It gives its name to one of the settlements of the island, viz. Sambaquichaba, *i. e.* Chan de Quichaba, the plain of the Quichaba; but we did not see any specimens there during our visit. The tree seems to prefer stony and even rocky ground on the exposed cliffs or in the thickets of the woods.

ACHRAS SAPOTA, *L.*

The Sapota is cultivated in the gardens, and fruits well.

ASCLEPIADEÆ.

GONOLOBUS MICRANTHUS, *Hemsl. 'Chall.' Report, Atlant. Isles*, p. 18, pl. xv.

The endemic plant is very common, clambering over the bushes in the more open spots, especially on the Burra shrubs. It occurs on the main island, Rat Island, and Sella Giueta.

The stems are covered with a thick corky bark. The flowers are small and green, with black spots at the base of the petals. The endemic Tyrant, *Elainea Ridleyana*, Sharpe, uses the pappus of the seeds to line its nest with.

LOGANIACEÆ.

SPIGELIA ANTHELMIA, *L. Sp. Pl.* ed. 1, p. 149; *Lam. Ill.* t. 107; *Prog. in Mart. Fl Bras.* vi. 1. p. 262.

In sandy spots, under the cocoa-nut palms, at Leao, and tolerably abundant in one spot. No doubt introduced. It is a common Brazilian weed.

APOCYNACEÆ.

Rauwolfia ternifolia, *Kunth, Syn. Fl. Æquin.* ii. p. 298; *Griseb. Fl. Brit. W. Ind.* p. 408.

Common on the main island in the open spots, especially in the central district. The flowers are pinkish white, the berries pink and of somewhat nauseous taste. The plant is called "Frutta di Sapo."

Distribution. Tropical South America.

Vinca rosea, *L. Sp. Pl.* p. 305.

This is grown in gardens, and has wandered a short way from them and half established itself in one or two spots near the village.

GENTIANEÆ.

Schultesia stenophylla, *Mart. Nov. Gen. et Sp.* ii. p. 106, t. 182, *et Prog. in Mart. Fl. Bras.* vi. 1. p. 207.—Reichartia rosea, *Karsten, Fl. Columb.* i. p. 59, t. xxix.

Very common in the central district, growing with *Ageratum conyzoides*, L., and other weeds. It also occurred on Morro branco. The flowers here were of a lurid pinkish cream-colour, while those found on the mainland of Brazil were almost yellow. We never found them coloured as shown by Martius or Karsten.

Distribution. Panama, West Indies, Guiana, Brazil, and Sierra Leone.

BORAGINEÆ.

Heliophytum indicum, *DC. Prodr.* ix. p. 556.—Heliotropium indicum, *L. Sp. Pl.* ed. 1, p. 130; *Griseb. Fl. Brit. W. Ind.* p. 485.

Is very common in the central district. It is known as "Fedegozi," and the leaves are made into a kind of tea for chest-complaints.

Distribution. Very common all over the world.

Cordia globosa, *H. B. K. Nov. Gen. et Sp.* iii. p. 76; *Griseb. Fl. Brit. W. Ind.* p. 481; *Browne, Hist. Jam. Pl.* t. 13. fig. 2.

A shrub in the more open parts of the Sapate. Among the bushes, with white flowers and orange berries.

Distribution. W. Indies, Mexico, and Panama.

Apparently not hitherto recorded from Brazil; but a specimen collected by Gardner appears to be this plant.

CONVOLVULACEÆ.

Ipomœa Tuba, *G. Don, Syst.* iv. 271 (1837); *Meissn. in Mart. Fl. Bras.* vii. p. 216.—I. grandiflora, *Lam. Ill.* i. 467 (1791).—Convolvulus Tuba, *Schlecht. in Linnæa*, 1831, p. 735.—Calonyction grandiflorum, *Choisy, Conv. Or.* p. 60; *DC. Prodr.* ix. p. 346.

Forms a large densely matted bed covering the rocky débris in Chaloupe Bay, where the stems attain a thickness of nearly 2 inches and a considerable length, exuding a copious white latex when cut. It is almost equally abundant on a slope at the base of the Peak; and occurred also on Platform Island. This is called "Salso da Praia" here.

Distribution. Antilles, Surinam, and Guiana; but it does not appear to be known from Brazil except from this locality. It was only found on the north side of the island, and probably the seeds were drifted on to the island from the north.

I. muricata, *Jacq. Hort. Schœnbr.* iii. p. 40, t. 323, *non H. B. K.*—Calonyction speciosum, var. muricatum, *DC. Prodr.* ix. p. 345.

On the extreme north of the Sapate among bushes, on Cape Placellière; also in the central district. Flowers pink; open in the evening.

Distribution. World-wide?

I. Quamoclit, *L. Sp. Pl.* p. 227.

Occurs in the gardens, where it is cultivated to a small extent under the name of "Prima vera."

I. Pes-Capræ, *Sweet, Hort. Sub. Lond.* ed. 2, p. 289; *Meissn. in Mart. Fl. Bras.* vii. p. 256.

This is very common in all the sandy bays on the main island; especially abundant on the sand-hills at San Antonio and at Sambaquichaba, Portuguese Bay, &c. Some of the stems attained a length of 30 feet.

Distribution. World-wide.

I. Batatas, *Lam. Encyc.* vi. p. 14; *Meissn. in Mart. Fl. Bras.* vii. p. 281.—Convolvulus Batatas, *L. Amœn. Ac.* vi. p. 121.

The Sweet Potato is cultivated in many parts of the main island and has run half wild in many spots; but it is most abundant on Rat Island at the place covered with guano. Here it is very profuse, owing to the richness of the soil; and the main island is supplied with the tubers from this spot.

IPOMŒA DIGITATA, *L. Sp. Pl.* p. 228; *Meissn. in Mart. Fl. Bras.* vii. p. 278.—Batatas paniculata, *Choisy, Conv. Or.* p. 54.

Tolerably common in spots in the central district, growing among the Leguminosæ.

Distribution. Throughout the tropics.

I. PENTAPHYLLA, *Jacq. Coll. Bot.* ii. p. 297; *Ic. Pl. Rar.* ii. p. 319.—Convolvulus pentaphylla, *L. Sp. Pl.* ii. p. 223; *Meissn. in Mart. Fl. Bras.* vii. p. 287.

This Convolvulus was very common in the central district of the main island, and also in Rat Island.

Distribution. Over the whole world.

JACQUEMONTIA EURICOLA, n. sp.

Herba prostrata vel suberecta, ramosa pubescentia glauca undique tecta. Folia cordata ovata acuta, 2 uncias longa, $1\frac{1}{2}$ uncias lata, petiolus uncialis. Flores congesti in capitula parva, pedunculis 2-uncialibus suberectis axillaribus et subterminalibus. Bracteæ plures, lanceolatæ acutæ, circiter $\frac{1}{4}$-unciales. Sepala 5, pubescentia valde inæqualia 2 ovata lanceolata acuminata $\frac{1}{4}$-uncialia, 3 minora ovata acuta. Corolla campanulata $\frac{3}{4}$ unciam longa, pallide azurea, $\frac{1}{2}$ unciam in diametro. Stamina 5, pistillum haud superantia. Anthera ovalis, loculis haud disjunctis. Ovarium conicum obtusum. Stylus gracilis rectus; stigma bilobum, lobis ovalibus.

Rat Island, southern side; main isle, on the southern side, from near San Antonio to Tangle Bay, growing on open spaces facing the sea.

A very pretty delicate lavender-blue Convolvulus, almost white at times, with stem and leaves covered with a close grey pubescence.

CUSCUTA AMERICANA, *L. Sp. Pl.* p. 180; *Jacq. Amer.* p. 24; *Meissn. in Mart. Fl. Bras.* vii. p. 376, t. cxxvi. fig. 1.

Not rare on the main island; parasitic on *Cucumis Anguria*, L.,

in Chaloupe Bay, and on *Ipomœa Pes-Capræ* in Pirate's Creek; also Rat Island.

Distribution. Common in Tropical America.

Cuscuta globosa, n. sp.

Caules tenues longi rubri. Flores perparvi $\frac{1}{8}$ unciam longi, virescenti-albi, papillosi, in glomerulis dense congesti unciam in diametro. Pedicelli teretes ferme $\frac{1}{4}$-unciales. Bracteæ ovatæ acutæ papillosæ. Sepala 4 carnosula ovata subacuta, erecta. Petala 4 haud reflexa tenuiora haud multo longiora angustiora oblonga, tubo brevissimo. Stamina 4, petala non superantia, filamenta basi incrassata. Antheræ rotundatæ brunnescentes. Staminodia? brevia digitata subspathulata. Ovarium globosum apice depresso. Styli 2, inæquales graciles, ovarium multo longiores. Capsula globosa parva. Semina 2.

Main island, only parasitic upon Leguminosæ, *Æschynomene*, *Philoxerus*, and *Amaranthus*, &c. Summit of Morro branco and near Tangle Bay.

This species I at first thought might be a form of *C. decora*; but on examining that species, I found that the flowers were considerably larger, the petals reflexed, and the ovary almost conical. *C. globosa* is remarkable for its very small flowers in dense balls clustered on the branches of the host, the stems, which are very slender, soon disappearing. The petals, sepals, and bracts are covered with little papillæ arranged in lines. The petals are not recurved, but almost connivent, very deeply cut, so that there is hardly any tube.

SOLANACEÆ.

Capsicum frutescens, *Willd. Sp. Pl.* i. p. 1050; *Sendtn. in Mart. Fl. Bras.* x. p. 142.

The Capsicum, which is commonly cultivated, is very abundant in a half-wild state in the Sapate and other bushy spots, the seeds being apparently scattered about by the doves which devour it.

C. sp.? is also cultivated in gardens, and fruits well.

Lycopersicum esculentum, *Mill. Gard. Dict.* ed. viii. n. 2.

Is cultivated also to a considerable extent, and has also run half-wild everywhere. The half-wild form is a small plant, with round orange berries as large as a cherry; and it is stated that the large-

fruited forms cultivated here speedily revert to the small-fruited form.

Datura Stramonium, *L. Sp. Pl.* ed. 1, p. 179.

It is common in and round the village. It is called "Stramondi," and used in medicine. The flowers open a little after 6 o'clock, *i. e.* just after sunset. I never saw any insects at them, though we watched them. It fruits extensively.

D. fastuosum, *L.*

Is cultivated in gardens as an ornamental plant.

Nicotiana Tabacum, *L.*

A little tobacco is grown here, but of inferior quality.

Physalis viscida, n. sp.—P. hirsuta, var.?, *Hemsl. Exped. 'Challenger,'* pt. ii. p. 19.

Herba suffruticosa, pedalis vel brevior, sæpe omnino glanduloso-pubescente, pilis simplicibus. Folia ovata subacuta dentata, 1–1½ uncias longa, ¾ unciam lata, petioli unciali. Flores parvi flavi immaculati nutantes, iis *P. minimæ* æquales, pedicellis gracilibus ¼ unciam. Sepala 5 lanceolata acuminata hispida sub anthesi non dilatata. Corolla pallide flava, ½ unciam longa, petala obtusa pubescentia præsertim intus campanulata. Stamina linearia flava angusta. Stylus gracilis, apice acuminato. Stigma capitatum. Bacca parva globosa viridis; calyx fructifer ovatus uncialis parce pubescens, lobis acuminatis angustis, pubescentioribus. Semina plana rotundata reniformia brunnea punctata.

Common in various parts of the main island in bushy spots. When growing in dry rocky or sandy spots it is more stunted and spreading and very viscid, covered all over with the glandular hairs. In the more bushy spots it is taller, slenderer, and more herbaceous, and less pubescent. It seems to be quite distinct from any form of *P. hirsuta*, Dunal, as it has neither violet anthers nor a spotted corolla. From *P. minima*, L., again it differs in the shape of the calyx in fruit, which has an ovate-acuminate outline, the free portion of the sepals being narrow, lanceolate acute, and very hairy. The interior of the corolla is very pubescent.

Solanum oleraceum, *Dunal, Syn.* p. 12; *Dunal in DC. Prodr.* xiii. p. 51.—S. nigrum, var., *Sendtn. in Mart. Fl. Bras.* x. p. 17.

In several spots in the Sapate, but always near the convicts'

huts. The flowers are small and white. It certainly looks very unlike any form of the European *S. nigrum*.

Distribution. Brazil, common and widely spread.

SOLANUM PANICULATUM, *L. Sp. Pl.* ed. 1, p. 267; *Dunal in DC. Prodr.* xiii. p. 278; *Sendtn. in Mart. Fl. Bras.* x. p. 80.

About the village in waste places and at San José (Platform Island), abundant in the ruined fort. A loose little branched straggling shrub about six feet high, with violet or almost white flowers.

Distribution. Brazil; common round Pernambuco.

S. MAMMOSUM, var. CORNICULUM.—S. cornigerum, *André in Rev. Hort.* 1868, p. 33, *non Dunal* (S. corniculatum *in tab.*).

The true "Jurubeba." This plant occurs in waste places round the village. The fruit is used in liver complaints. The name "Jurubeba" is commonly applied to any *Solanum* of this group; but this, I was assured, was the correct plant. It is doubtless introduced here. This species seems not to be specifically distinct from *S. mammosum*, which, however, is not hitherto known from Brazil. The form of the fruit, which is rather larger than *S. mammosum*, and has an irregular number of processes at the base, seems to be the only distinguishing mark.

S. BOTRYOPHORUM, n. sp.

Frutex scandens, caulibus lignosis ferme unciam diametro; cortex suberosus albescens. Rami graciles glabri. Folia valde variabilia membranacea nonnunquam integra ovata lanceolata acuta petiolata, circiter 2 uncias longa, unciam lata, sæpius triloba, lobus medius ovato-lanceolatus 2–3 uncias longus, unciam latus, lateralia breviora falcata; haud raro præsertim in plantis juvenibus multilobata vel runcinata. Paniculæ nutantes multifloræ, ramosæ densæ pulcherrimæ. Flores eis *S. Seaforthiæ* subæquales, violaceæ, conniventes; pedicellis $\frac{1}{4}$ unciam longis. Calyx viridis parvus, dentibus parvis 5. Corolla $\frac{1}{2}$-uncialis, lobi 5, lanceolatæ acutæ, marginibus pubescentibus. Stamina 5, filamentis brevibus basi incrassatis, ad apicibus acuminatis; antheræ flavæ conicæ, conniventes, poris magnis duobus dehiscentes. Stylus gracilis curvulus; stigma capitatum parvum. Ovarium globosum. Baccæ parvæ globosæ coccineæ.

This beautiful plant was very abundant in the Sapate, and

also occurred on the east hills. In the woods it climbed over the shrubs, and formed almost impenetrable barriers. The stem at the base was often strong and thick, and covered with a corky bark. The leaves are very variable in shape, usually glabous; but in seedlings the margins are often edged with fine white hairs. The flowers form large pendent masses, and are of a fine violet colour, with a paler stripe in the centre of each petal; they never seem to open wide. The berries are about the size of those of *Solanum Dulcamara,* but globose and of a bright scarlet.

The plant is allied closely to *S. Seaforthiæ,* Andr.

SCROPHULARIACEÆ.

SCOPARIA DULCIS, *L. Sp. Pl.* ed. 1, p. 116; *DC. Prodr.* x. p. 431; *J. A. Schmidt in Mart. Fl. Bras.* viii. 3. p. 264.

Common on the main island, especially between the village and Fort San Antonio. Also very abundant on Rat Island. It is called here "Vassorinha," and reputed as a medicine for consumption.

Distribution. All the tropical world.

S. PURPUREA, n. sp.

Herba erecta, radice crassa lignosa, ramis erectis. Folia subverticillata, juniora angusta lanceolata integra, adulta cuneata runcinata basi angustata, dentibus acutis. Flores parvi 2–3 in axillis, pedicellis decurvis .... Calyx 4-fidus, sepala lanceolata acuta. Petala 4, ovata subobtusa vel lanceolata acuta, roseopurpurea, pilis perpaucis. Stamina 4, filamenta glabra. Antheræ ellipticæ oblongæ, loculis basi disjunctis. Ovarium conicum; stylus cylindricus; stigma capitatum. Capsula globosa sepala vix superans. Semina minuta oblonga, atro-brunnea reticulata.

Rat Island; on the north side by the sea-shore, a few plants.

The colour of the flowers, pale rose, and almost complete absence of hairs from the base of the petals, so conspicuous in *S. dulcis,* distinguish this species from that; the habit is more erect and stiff, and the leaves larger and more toothed.

BIGNONIACEÆ.

BIGNONIA ROSEO-ALBA, n. sp.

Frutex altus, 15-pedalis vel ultra, caulis diametro ad 6-unciali, ramis strictis nec scandens, cortice brunneo verrucoso alabastris nigris. Folia trifoliolata, foliola ovata acuta vel ovata lanceolata superne glabra obscure viridia, subtus griseo-pubescentia, 5 uncias longa, $2\frac{1}{2}$ uncias lata, petiolus $\frac{1}{2}$-uncialis angulatus. Flores terminales pauci fugaces, pulchri. Calyx bilabiatus, $\frac{1}{2}$-uncialis, lobus inferior bilobus, omnes oblongi obtusi, marginibus pubescentibus brunneis. Corolla tenuis sub-bilabiata 2 uncias longa, tubo dilato, lobi 5, lati rotundati, rosea et alba, signis flavis in labio inferiore, marginibus minutissime ciliatis. Stamina 5, filamentis gracilibus, basi hispidis. Antheræ versatiles arcuatæ angustæ brunneæ; appendice minima. Pollen albescens. Stylus gracilis albus. Stigma truncatum emarginatum. Ovarium teres purpurascens, discus parvus annularis viridis. Fructus immaturus gracilis teres.

This shrub, almost attaining the dimensions of a tree, is very abundant in the Sapate; also on Look-out Hill; but is very much sought for firewood, so that large plants of it are not very common. Its flowers are borne in the axils of the upper leaves, and are very thin and fugacious. The corolla is rose-colour and white, irregularly mingled with some yellow markings in the lower lip and throat. The buds are black, like those of an ash-tree. The fruit we could only procure immature, inasmuch as the plant flowered only towards the end of our stay in the island. It seemed to be slender, cylindrical and curved.

VERBENACEÆ.

LANTANA LILACINA, *Desf. Cat. Hort. Par.* ed. 3, p. 392; *Schau. in Mart. Flor. Bras.* ix. p. 261, t. xliv. fig. 1.—L. fucata, *Lindl. Bot. Reg.* t. 798.

In and about the gardens of the convicts. I never saw it wild.

L. AMŒNA, n. sp.

Frutex mediocris, ramis tetragonis hispidis præsertim versus apices gracilibus. Folia ovata acuta denticulata, in petiolo decurrentia undique cinereo-pubescentia aromatica, lamina 2 uncias

longa, $1\frac{1}{2}$ uncias lata quo latissima. Capitulæ parvæ globosæ, $\frac{1}{2}$ unciam longa. Bracteæ lanceolatæ acutæ pubescentes. Calyx brevis bilobus pubescens. Corolla alba fauce flava $\frac{1}{4}$-uncialis, tubo gracili curvo extus glanduloso pubescenti, lamina bilabiata, labio superiore trilobo, lobis rotundatis, labio inferiore rotundato latiore emarginato, fauce hispido. Stamina 4. Antheræ latæ oblongæ, filamenta brevia. Stylus crassus; stigmate laterali rotundato parvo. Ovarium rotundatum pubescens. Drupa minima pubescens, ferme exsicca, sicca valde aromatica.

In the thickets of the Sapate, tolerably plentiful. An infusion of the leaves is used as tea, as is the case with other species in Brazil. This species is allied closely to *Lantana cinerascens* in its dry nut, which, like the leaves, is deliciously aromatic.

LABIATÆ.

Hyptis pectinata, *Poit. in Ann. Mus. Par.* vii. p. 474; *Benth. in DC. Prodr.* xii. p. 127.—Nepeta pectinata, *L. Sp. Pl.* ed. 2, p. 799.

Abundant in the Sapate, where it grows to a height of about 6 feet. Flowers small, lilac.

Distribution. All parts of warm America. Also occurs in Africa and India.

H. suaveolens, *Poit. in Ann. Mus. Par.* vii. p. 472, t. 29. fig. 2; *Benth. in DC. Prodr.* xii. p. 126.—Ballota suaveolens, *L. Sp. Pl.* ed. 2, p. 815.—Bysteropogon suaveolens, *L'Hérit. Sert. Angl.* p. 17.

In open places on Tobacco Point, and also on the cliffs on Portuguese Bay, where the whole air was scented with it. It attains a height of from 4–5 feet. Flowers larger than the preceding, blue.

Distribution. Common in Tropical America, and occurring also in the East Indies.

PLANTAGINEÆ.

Plantago major, *L. Sp. Pl.* ed. 1, p. 112; *J. A. Schmidt in Mart. Fl. Bras.* vi. p. 169.

This occurred as a garden-weed in the precincts of the Governor's house; and was no doubt accidentally introduced. It has some reputation here as a medicine in chest complaints. The

plant seems to be scattered about on the coast-line of Brazil, from Bahia to Rio de Janeiro.

APETALÆ.

NYCTAGINEÆ.

BOERHAAVIA DIFFUSA, *Sw. Obs.* p. 10.—B. paniculata, *Rich. in Act. Soc. Hist. Nat. Par.* i. p. 105; *J. A. Schmidt in Mart. Fl. Bras.* xiv. 2. p. 369.

A common weed in the garden, in waste places, and also on the roads near Sambaquichaba and in the Sapate. Flowers bright pink. Also on Rat Island.

Distribution. Common all over the tropics.

B. HIRSUTA, *Willd. Phyt.* i. p. 23; *J. A. Schmidt in Mart. Fl. Bras.* xiv. 2. p. 370.

A specimen gathered by Moseley during the 'Challenger' Expedition seems to belong rather to this species. It was probably obtained in the village.

PISONIA DARWINII, *Hemsl. Voy. 'Chall.' Exped., Atlantic Isles*, p. 20, pl. xlvii.

This was described and figured from a poor specimen obtained by Charles Darwin during the voyage of the 'Beagle;' but the material obtained appears to have been so bad that both the description and figure are very misleading; therefore I think it will be more satisfactory to redescribe it.

Frutex altus vel arbor parva, foliis nitide viridia ovata vel ovata lanceolata acuta vel acuminata, superne glabra (sicca nigra) subtus pubescentia, lamina 4–7 uncias longa, 2–4½ uncias lata, petiolo rigido unciali; folia juvenilia cum ramis omnino ferrugineo-pubescentia. Flores congesti in capitulis parvis in apicibus ramis minimis, omnino ferrugineo-pubescentes. Perianthium tubulosum, lobis 5 brevibus acutis. Stamina.... Filamenta gracilia brevia, perianthium non superantia. Antheræ rotundatæ obtusæ, albæ. Stylus teres perianthio subæqualis, stigmatibus capillaceis ramosis. Ovarium conicum. Fructus dependens, oblongus, viridis, ½-uncialis, perianthio persistente coronatus striatus; sicca nigra.

This shrub or small tree is very common all over the main island. It attains a considerable size, and is conspicuous from

its glossy green leaves; but although so abundant, we only found a single tree in bloom. This, however, bore a plentiful supply of flowers and two fruits. The stems are covered with a grey bark; but the younger branches are thickly coated with a rusty-brown pubescence, which overlies not only the twigs but also the young leaves and inflorescence. The flowers are closely crowded into small heads at the ends of the branches and are very small. The perianth is red, with the rusty pubescence outside, glabrous within; the lobes short and acute. The stamens are represented in the plate above quoted as projected far beyond the perianth-tube; I never saw them like this. They are slender and short. The pistil is terminated by a tuft of filaments at the apex, as in most other species; these are omitted altogether in the plate, in which the pistil is mutilated. The fruit is oblong, slightly pubescent, and green when fresh, and marked with low ribs, and terminated by the remains of the perianth-tube: it hangs down when ripe.

AMARANTACEÆ.

AMARANTHUS CAUDATUS, *L. Sp. Pl.* ed. 1, p. 990, ed. 2, p. 1406.

A few scattered plants occurred near the village, in Peak Bay, and also in some of the gardens.

A. GRACILIS, *Desf. Tabl. Hort. Par.* ed. 1, p. 43.—Euxolus caudatus, *Moq. in DC. Prodr.* xiii. 2. p. 274.

Peak Bay, and also by the roadside in the central district.

Distribution. World-wide.

A. VIRIDIS, *L. Sp. Pl.* ed. 2, p. 1405.—Euxolus viridis, *Moq. in DC. Prodr.* xiii. 2. p. 274.

Along the paths through the Sapate. Common.

Distribution. World-wide.

PHILOXERUS VERMICULARIS, *R. Br. Prodr. Fl. Nov. Holl.* i. p. 410.—Iresine vermicularis, *Moq. in DC. Prodr.* xiii. 2. p. 340. —Var. AGGREGATA: Iresine aggregata, *Moq. l. c.*—Philoxerus aggregatus, *H. B. K. Nov. Gen. et Sp.* ii. p. 203.

This plant is exceedingly common along the shores of the main island, Rat Island, &c. It covers densely the fallen boulders on the hill-slopes just above the beach. The common form was the

variety *aggregata*; but in Chaloupe Bay, where it was very luxuriant, there was a form with conical heads nearly an inch in length, which is doubtless the variety *longespicata* of Seubert in Mart. Fl. Bras. v. p. 226.

Distribution. Tropical South America and Africa.

CHENOPODIACEÆ.

Chenopodium anthelminticum, *L. Sp. Pl.* ed. 1, p. 220; *Moq. in DC. Prodr.* xiii. 2. p. 73; *Fenzl in Mart. Fl. Bras.* v. p. 150.

Cultivated as a medicinal plant in many of the gardens, and escaped thence in several places.

Basella alba, *L. Gen. Pl.* n. 382; *Jacq. Eclog.* t. 161.

Occurred as a garden-weed in the Governor's garden and also in the village.

PHYTOLACCACEÆ.

Rivina lævis, *L. Mant.* p. 41; *Lam. Ill.* t. 81. fig. 2; *J. A. Schmidt in Mart. Fl. Bras.* xiv. 1. p. 335.

Common everywhere on the main island and also on Rat Island, where the plants formed shrubs. The flowers of this form were white, the berries at first orange-yellow, after red. On the slopes towards the sea at Tobacco Point was another form with reddish stems and pinkish flowers.

Distribution. Common all over Tropical America; very plentiful at Pernambuco.

EUPHORBIACEÆ.

Euphorbia comosa, *Vell. Fl. Flum.* t. 15; *Boiss. in DC. Prodr.* xv. 2. p. 66; *Muell.-Arg. in Mart. Fl. Bras.* xi. 2. p. 693.

In open stony places, in Chaloupe Bay and near Tangle Rock. It is called "Alvelose," and used medicinally.

Distribution. Brazil only? chiefly known from the south.

E. pilulifera, *L. Amœn. Acad.* iii. p. 114; *Boiss. in DC. Prodr.* xv. 2. p. 21; *Jacq. Ic.* i. t. 478; *Muell.-Arg. in Mart. Fl. Bras.* xi. 2. p. 184.—E. hirta, *L. Amœn. Acad.* iii. p. 114.—E. capitata, *Lam. Encycl.* ii. p. 422.

Abundant in the garden and village; also at Sambaquichaba and near Tangle Rock. A common prostrate weed.

Distribution. World-wide.

EUPHORBIA THYMIFOLIA, *Burm. f. Fl. Ind.* p. 2; *Boiss. in DC. Prodr.* xv. 2. p. 47; *Ic. Thes. Zeyl.* t. 105; *Muell.-Arg. in Mart. Fl. Bras.* xi. 2. p. 684.—E. thymifolia, var. β, *L. Amœn. Acad.* iii. p. 115.

A common weed in the garden and village; also in other half-cultivated spots.

Distribution. Cosmopolitan.

E. HYPERICIFOLIA, *L. Sp. Pl.* ed. 1, p. 454; *Hook. Exot. Fl.* i. t. 36; *Boiss. in DC. Prod.* xv. 2. p. 23.—E. cuspidata, *Bertol. Misc. Bot.* iii. p. 433, t. 22. f. 2.

On the sea-shore among stones, not common, below the Sapate near Cape Placellière. Rat Island, north side.

Distribution. West Indies, Mexico, Guatemala, Guiana.

MANIHOT UTILISSIMA, *Pohl, Pl. Bras.* i. p. 32, t. 24; *Muell.-Arg. in Mart. Fl. Bras.* xi. 2. p. 457, *et in DC. Prodr.* xv. 1. p. 1064.

The cultivation and preparation of the Cassava occupies much of the time of the convicts. A considerable quantity is grown for use in the island and for export. It does not appear to escape from cultivation, nor have I seen it here in flower.

RICINUS COMMUNIS, *L. Sp. Pl.* ed. 1, p. 1006; *Muell.-Arg. in Mart. Fl. Bras.* xi. 2. p. 420.

The common form here seems to be the var. *brasiliensis* of Muell.-Arg. It is very common in every part of the main island except the wooded districts; and also occurs plentifully on Rat Island. It does not appear to be cultivated.

JATROPHA CURCAS, *L. Sp. Pl.* ed. 1, p. 1006; *Jacq. Hort. Vindob.* iii. p. 36, t. 63; *Muell.-Arg. in Mart. Fl. Bras.* xi. 2. p. 487.

There were a few shrubs of this species in the village, forming hedges with the other species. It is used in medicine.

J. POHLIANA, *Muell.-Arg. in Mém. Soc. Phys. Genèv.* xvii. 2, p. 499; *Boiss. in DC. Prodr.* xv. 2. p. 1091; *Muell.-Arg. in Mart. Fl. Bras.* xi. 2. p. 492.—Var. SUBGLABRA.

This is the plant collected by Moseley during the 'Challenger' Expedition, and not *I. gossypifolia* as published, from which species it is very distinct. It is very abundant on Rat Island and the main isle, and is very conspicuous from its bluish-grey bare branches. It grows on the open parts of the whole island

in the form of a branching bushy shrub, bare except at the apex of the branches. In the Sapate it attains a tree-like form and habit, with a stem 2 inches in diameter, and white bark like that of birch. When cut it exudes a slimy juice which stains linen permanently. The open flowers are not red in this form at least, but bright yellow, the petals tipped with red, and the buds red. The leaves are almost glabrous, but there is a fine pubescence along the edge. It is very common round Pernambuco, and forms hedges in the suburbs.

Distribution. Brazil.

JATROPHA URENS, *L. Sp. Pl.* ed. 1, p. 1007; *Muell.-Arg. in DC. Prodr.* xv. 2. p. 1100, *et in Mart. Fl. Bras.* xi. 2. p. 500; *Jacq. Hort. Vindob.* t. 21.

Common and widely scattered in Rat Island, Sella Giueta, and the main island. The form here corresponds with the var. *genuina* of Muell.-Arg. It has, however, less deeply cut and more rounded leaves with no teeth, and but slight sinuations along the edges. It is not the common form round Pernambuco. The whole plant, including even the apices of the petals, is covered with stinging hairs. It is a small shrubby plant about 2 feet high, with spreading branches and white flowers of medium size. I am informed by Senor Mendonça that good thread is obtained from this plant. It is called "Ortega branca" and "Cançançao" by the natives, who say that leaves or branches of this plant put in a mouse's hole will at once drive away the occupant.

Distribution. All warmer parts of America.

PHYLLANTHUS LATHYROIDES, *Muell.-Arg. in Linnæa,* xxxii. p. 42; *in DC. Prodr.* x. 2. p. 404; *in Mart. Fl. Bras.* xi. 2. p. 52.

Very common and variable in open spaces and waste ground, Rat Island, near the blowhole. Main island everywhere, except in the wooded districts. A form with variegated leaves occurred at Sueste. The common form here appears to be the var. *commutata,* Muell.-Arg., as the filaments of the stamen are but shortly free at the top.

This is the plant referred to *P. brasiliensis,* Muell.-Arg., in the Voyage of the 'Challenger,' p. 22.

CROTON ODORATUS, n. sp.

Frutex ramosus suaveolens, virgulta densa formans 4–6-pedalis. Rami lignosi, cortice griseo verruculoso tecti, apicibus

juniorum pubescentibus. Folia ovata acuta, dentata, palminervia, undique parce stellato-hispida præsertim in venis, lamina 2 uncias longa, 1½ uncias lata, petiolus patulus, 1½ uncias longa. Stipulæ breves integræ lanceolatæ, basi glandulosæ pubescentes. Racemi terminales singuli erecti, rhachide pubescente, 4-unciales. Flores feminei pauce dissiti ad basin racemi 3–4, masculi plures congesti, feminei remoti. Flores masculi, pedicelli breves dense albo-pubescentes. Sepala 10, ovata obtûsa pubescentia. Petala 5, lanceolata, linearia obtusa tenuia alba, filamentis æqualia. Stamina 9, filamenta graciles ferme nudi. Antheræ rotundatæ. Discus pubescens, glandulæ pulvinatæ rotundatæ. Flores feminei majores, pedicellis ut in masculis. Sepala oblonga lanceolata viridia pubescentes inæqualia non glandulosa, 5. Discus glandulis factus rufus. Petala nulla. Ovarium subtriangulatum omnino alba pubescentia tectum. Styli 3, brachia in utro 4 rufescentia. Capsula parce pubescens. Semina oblonga, marginibus obtusis, atro-brunnea undique minute punctata; caruncula alba.

A bush of considerable size in the wooded districts, in more open parts usually about 4 feet high, but sometimes 10 feet in height, the stems 2 inches through; forming dense thickets very difficult to penetrate. Very common on the main island, especially in the west at Tangle Rock and in the Sapate; a thicket of it occurred above S. Antonio Bay, and it also occurred on Rat Island.

The wood is compact, hard, and white. The leaves are very pleasantly aromatic when bruised; they are of a light green, turning bright red on withering. The plant is allied to *Croton populifolius* of the West Indies.

ACALYPHA NORONHÆ, n. sp.

Suffrutex pedalis, caulibus juvenilibus pubescentibus. Folia ovata lanceolata acuminata crenato-dentata, parce hispida, lamina ad 4 uncias longa, 2 uncias lata ad basin, petiolus 3-uncialis; stipulæ lanceolatæ acuminatæ pubescentes. Racemi plures in axillis foliorum 2-unciales, floribus femineis paucis dissitis ad basin cæteris masculis congestis. Bracteæ femineæ ferme integræ, cordatæ, marginibus ciliis glandulosis munitis; stipulæ lineares lanceolatæ pubescentes, bractea haud superantes. Perianthium. . . . . Ovarium sessile, obtuse trigonum densè albo-pubescens; styli valde ramosi tenues kermesini. Capsula parva,

hispida. Semen ellipticum brunneum punctatum. Flores masculi plurimi, globosi breviter pedicellati, in capitulis munitis congestis. Bracteæ breves, flores vix superantes, laciniatæ. Sepala 4 ovata obtusa. Stamina 5, filamentis brevibus. Antheræ arcuatæ, loculi recurvi, discus parvus.

On the slopes of the Peak, among the boulders. A small shrubby plant, tolerably plentiful at this spot, but not seen elsewhere.

TRAGIA VOLUBILIS, *L. Sp. Pl.* ed. 1, p. 980; *Muell.-Arg. in DC. Prodr.* xv. 2. p. 935.

We did not find this plant during our visit; but some fruits and leaves were sent afterwards. It is termed "Ortega trepadeira" and "Tamiarana;" and reported to be so poisonous that any animal eating it among other herbage speedily dies.

Distribution. West Indies, Brazil, and Peru.

SAPIUM SCELERATUM, n. sp. (Plate III.)

Arbor magna ad 30-pedalis, ramosa, valde laticifera, cortice griseo. Folia iis *Pruni Laurocerasi* simulantia tenuiora, lanceolata, marginibus dentatis, glandulis parvis conicis ad basin laminæ et rarius in marginibus; lamina atro-viridis nitens ad 5 uncias longa et 2 uncias lata, petiolus uncialis cum glandulis rufus. Stipulæ brevissimæ ovatæ. Racemi $1\frac{1}{2}$-unciales, in apicibus ramorum foliis denudatorum, rhachide crassiusculo, floribus femineis 1–2 ad basin, masculis pluribus remotiusculis. Flores feminei: glandulæ 2 oblongæ, ad basin sæpe sepala minuta ovata 3, ferme cœlantes. Pistillum conicum crassum. Styli rufescentes, recurvi, validuli. Flores masculi plures 4 congesti, glandulis duabus ut in femineo. Sepala 2, oblonga ovata obtusa viridia, apicibus roseis. Stamina 2, filamentis basi subincrassatis, apice attenuatis. Antheræ conicæ flavæ. Capsula parva globosa, bivalvis, $\frac{3}{8}$ unciam longa, crassiuscula, columella persistens. Semen unicum ovatum griseum, $\frac{1}{4}$ unciam longum, basi rotundata, apice acuto, uno latere complanato.

This plant, known as the "Burra," occurs on all the islands of sufficient size—Rat Island, Sella Giueta, and all parts of the main island. Although mentioned by Webster under the name of the laurelled Bara, and alluded to by Darwin and Moseley, specimens do not seem ever to have been brought to this country, at least adequate for description; indeed, no one seems to have

seen the flowers: flowering specimens were by no means easy to obtain, as the plant had hardly any flowers when we left the island; they only appear on trees which have shed their leaves at the approach of the hot season. The Burra is one of the largest trees on the island, attaining a height of about 30 feet and a very considerable thickness. It has wide spreading branches, which in old trees are but thinly covered with leaves. The bark is smooth and grey. Every portion of the plant, except the wood, exudes when wounded an abundant white latex of very acrid nature. This is so poisonous, that it is said to burn off the hair of horses and cattle where it touches the skin; and care is taken not to tie a horse up to a burra-bush. As the twigs are very brittle, persons pushing through a bush are liable to get the milk thrown in the eye, when it is stated to cause blindness. Mr. Lea met with this accident on one occasion on Sella Giueta, a drop of the milk entering one of his eyes, creating a bad inflammation which lasted for some hours. Human milk and urine are recommended as lotion in such an accident. Some of the convicts planted hedges of it round their gardens in order to deter thieves from breaking in at night.

The leaves of the plant resemble those of the Portugal Laurel, which resemblance is increased by the strict habit of the branches of the young plants. They are deep shining green, with a red petiole, and rather thin in texture, unlike those of *Sapium biglandulosum*. On the upper part of the petiole are two little conical red glands; and similar glands occur also not rarely upon the margins of the blade. The racemes are very short, not more than 1½ inch long, with one or two sessile female flowers at the base, the upper portion being covered with the male flowers in little clusters of four. The female flowers are single, and just below them are a pair of oblong succulent pinkish glands. The perianth of three lobes is very minute, and often hardly visible on account of the glands; the pistil is green and conical, but constricted towards the apex; the styles are recurved, thick and red. Below each cluster of male flowers is a pair of glands like those of the female flower. There are usually four flowers in a cluster, opening one after another; each consists of a pair of small perianth-segments, alternating with which are a pair of stamens. The capsules are small, subglobose, and bluntly 3-angled; and contain a single grey seed a quarter of an inch long, broad and rounded at the base and more acute at the apex.

Although the seeds are so acrid and poisonous, yet I am informed by the Director of the island that the small birds eat them largely, and pass them unchanged. "So when it rains we meet with little burra-trees, which are cultivated. Thus it is well seen that such birds should be very well able to cover in a short time the whole island with burra-trees, as it was once, if it was not inhabited any more." This accounts for the diffusion of the plant into every corner of the island.

URTICACEÆ.

Ficus Noronhæ, *Oliver in Hook. Ic. Plant.* xiii. t. 1222, p. 18; *Hemsl. Voy. 'Chall.,' Bot. Atlantic Isles*, p. 23.

This Fig-tree, peculiar to this group of islands, was partially described and figured in the above-mentioned place from material obtained by Moseley. The description is, however, incomplete from poverty of material; and therefore I think it well to redescribe it.

Arbor magna, radicibus aeriis copiosis longissimis, ad 15-pedalibus, cortice griseo lævi, in plantis junioribus, in vetustis rimoso, valde lacticifero. Folia coriacea atro-viridia nitida, elliptica obovata obtusa, 4–9 uncias longa, $2\frac{1}{2}$–4 uncias lata, petiolus incrassatus, $\frac{1}{2}$–1 unciam longus. Receptacula globosa unciam in diametro, viridia, maculis purpureis vel omnino purpurea, bracteis inferioribus 3, ovatis obtusis. Flores masculi et feminei undique commixti in receptaculo. Bracteæ lanceolatæ dentatæ, floribus æqualibus. Flores masculi quam feminei pauciores, stipitati vel sessiles, bracteolis duabus ad basin. Perianthium trilobum, lobi ovati obtusi. Stamen unicum, filamento crasso. Anthera terminali plana, oblonga, loculis approximatis. Flos femineus stipitatus vel sessilis, bracteolis 2 lanceolatis integris iis masculi similes. Perianthium trilobum, lobis ovatis obtusis. Stylus gracilis breviter e perianthii extrorsus bifidus, ramis brevibus recurvis. Ovarium ellipticum. Fructus ovalis. Semen ovale, 1 mm. longum, album.

Rat Island, Sella Giueta, main island.

This tree has been so extensively cut down, that but few of any size are now left in the islands. It attains its greatest dimensions in the Sapate; but does not grow in the thickest part of the woods, but in the more open spots. The finest trees now in existence are in the garden of the Director's house, where four

very large specimens grow on the banks of the stream. On the cliffs, as at the Peak, and on very exposed spots, as at Rat Island, it is of much lower growth, and forms a shrub creeping over the rocks by means of its aerial roots, or springing from clefts. Small bushes of it grow in the highest and most inaccessible parts of the Peak, and on some of the smallest islands, as the Dois Irmaos. The roots are very long, slender and tough, of a light brown colour; and are used to make whips for chastising the convicts. The bark and leaves, when broken, emit much milk, are very sticky, and apparently contain a considerable amount of caoutchouc; this milk is used as bird-lime. The leaves are glossy dark green, and much infested by galls. The figs are rounded, and either green with purple spots, or entirely purple; they are about an inch through when ripe, and are sweet and of somewhat pleasant flavour; at their base are three short oval bracts. The bracts at the mouth of the receptacle are numerous, nearly all being inverted, the two everted ones forming a short conical umbo. The flowers of both sexes are irregularly mixed, the females being most numerous. Among them are many laciniate bracts; and each flower is subtended by two small bracteoles. Many of the flowers are supported on a stalk, others are quite sessile. The perianth seems to be similar in both the male and female flowers, consisting of three short overlapping oval blunt lobes. The style is short and bifid.

The plant is called "Gamaleira" here, as are other species of the genus in Brazil.

Artocarpus incisa, *Forst.*

Several Breadfruit-trees occur in the gardens and in various spots in the village. On one tree a male spike was found at the base of which were female flowers.

Fleurya æstuans, *Gaudich. in Freyc. Voy. Bot.* p. 497.—Urtica æstuans, *L. Sp. Pl.* ed. 2, p. 1397; *Jacq. Hort. Schœnbr.* iii. t. 388.

This plant occurred sparingly on Tobacco Point, growing among *Philoxerus vermicularis* and *Canavalia*, and also by the lake. Specimens obtained in the latter locality were slightly stinging, and had very widely spreading panicles. It appears to be very variable; and specimens obtained at Pernambuco, where it is

common, differed somewhat in appearance from both the forms met with here.

Distribution. All over tropical S. America.

MONOCOTYLEDONS.

There were no petaloid Monocotyledons in the island except a few introduced by man; and these had hardly established themselves. An *Hymenocallis*, an *Aloë*, *Zanonia discolor*, and *Furcræa gigantea* occurred in the gardens, the latter cultivated for its fibre, as elsewhere in Brazil. Bananas of several varieties were largely cultivated, and sold for from six to nine for a vintem (about a halfpenny). The largest and richest plantation was on the slopes of the Peak.

PALMÆ.

Cocos nucifera, *L. Sp. Pl.* ed. 1, p. 1188.

Cocoa-nuts are largely cultivated in the sandy bays at Sueste and Sambaquichaba, and in one or two other spots. All the trees on the island are the property of the Director, none of any large size, and appear to be comparatively recent introductions. They fruit very well, and are usually loaded with nuts. At Sueste was a specimen with a branched stem; the main stem had apparently fallen forward from shifting of the sand, and had then thrown up a second stem.

Copernicia cerifera, *Mart.*

Carnauba Palm. There were a few young plants of this near the Peak, and a larger one in the village.

Oreodoxa regia, *Kunth.*

The are two trees of this palm by the door of the church.

CYPERACEÆ.

Cyperus circinatus, n. sp. (Plate II. figs. 1, 2.)

Pusillus, 2–5-uncialis, culmis pluribus flaccidis, vaginis paucis papyraceis ad basin. Folia pauca angustissima linearia circiter uncialia, culmis haud æquantia. Culmi triquetri 2–5-unciales, umbellis simplicibus breviter 1-radiatus aut subcapitatus, spiculis dissitis $\frac{1}{2}$-uncialibus, apicibus circinatis; bracteæ 3 lineares acuminatæ, marginibus scabridis longissimis, circiter 3 uncias longæ,

et ferme $\frac{1}{16}$ unciam latæ. Spiculæ ad 20-floræ angustæ. Rhachis sinuata tenuis. Squamæ lanceolatæ subacutæ, flavæ; carina viridi. Stamen unicum. Stylus bifidus ruber, squamam vix superans. Caryopsis oblonga, apice breviter mucronato, testacea puncticulata obscure biconvexa.

This little *Cyperus* was only met with in clefts of rock on the Peak, and on the slopes of Morro branco. It is 2-styled, the nut being rather long and almost terete, showing very slight traces of biconvexity. The spikelets, which are slender and have the flowers rather distant, are curiously curled at the apex in most cases.

CYPERUS COMPRESSUS, *Presl, Rel. Hænk.* iii. p. 177; *Rottb. Gram.* p. 28, t. 9. fig. 3; *Boeck. Cyp. Herb. Berol.* p. 121.

Common on the main island, on the sea-shore in Peak Bay, and also among the stones in the roads near San Antonio and in the village, as far west as Leao Bay, where a very dwarf form with short erect spikelets was seen. The plants were all small, as if the species had only begun to establish itself in the island.

Distribution. All tropical countries.

C. VIALIS, n. sp.

Annuus; basi vaginis rufescentibus tecti. Folia linearia acuminata acuta, 5 uncias longa, 1 lineam lata. Culmi validuli triquetri 7-unciales. Umbella triuncialis 4–6 radiorum erectorum, spiculis pluribus in apicibus congestis, et nonnullis sessilibus in medio umbellæ. Bracteæ 4, umbella subæquales, lineares acuminatæ. Spiculæ $1\frac{1}{2}$–$1\frac{3}{4}$ uncias longæ, graciles, 40–50-floræ, colore *C. compressi.* Squamæ lanceolatæ mucronatæ, marginibus late scariosis, carina viridi, lateribus sæpe rufescentibus. Stamina 3, filamentis gracilibus. Antheræ lineares apiculatæ. Stigmata 3, brevia rufa. Caryopsis oblonga angusta, trigona, angulis obtusis, testacea. Rhachis gracilis exalata.

Only two specimens of this plant were obtained, both at considerable distances apart along the roadsides, in the central district.

From its habitat I felt convinced it was an introduced plant, but have never been able to match it with any species. It is allied to *C. rotundus,* but the exceedingly long spikelets and form of the nut make it quite different. It has, too, the green and white colouring of *C. compressus,* and not the red glumes of *C. rotundus.* Mr. C. B. Clarke, to whom I showed the plants, pointed out the relationship to *C. rotundus* forma *viridis,* from which, however, he considers it distinct.

Cyperus brunneus, *Sw. Fl. Ind. Occ.* p. 116; *Griseb. Fl. Brit. W. Ind.* p. 565.—C. purpurascens, *Vahl.*—C. atlanticus, *Hemsl. Bot. Voy. 'Chall.,' Atlantic Isles*, p. 130, t. xxiii.—C. olidus, *Rich.*

The commonest species of this genus upon the island is identical with the *C. atlanticus*, Hemsley, obtained by Sir Joseph Hooker upon the island of South Trinidad; and I am quite unable to separate it from *C. brunneus*, Sw., of which there are type specimens in the British Museum. Swartz's specimens are small and stunted, but the plant grows much bigger and is very common throughout the West Indies, being apparently a sea-shore plant. I have seen it from Jamaica, Cuba, Tortola, St. Croix, Bahamas, Martinique, St. Bartholomew, Barbados, and it also occurs in Yucatan and Florida. Grisebach adds as synonym *C. insignis*, Kunth, based on Sieber's Trinidad plant, no. 7, which differs in the longer, more cylindrical nut, and narrower, more acute, almost unribbed glumes, and also in habit, and is the *C. planifolius*, Richard, as is shown by a type from St. Croix in the British Museum. *C. brunneus*, Sw., occurs on Fernando Noronha, on Rat Island, in the open country with *C. ligularis*, and on the main island at Leao Bay, Tangle Rock, Chaloupe Bay. In the sand of Portuguese Bay and on rocks at the end of the Sapate on Cape Placellière was a more glaucous form with pallid spikelets. In the open country it forms large tussocks very similar to those of *C. ligularis*. It varies greatly in breadth of foliage.

It is interesting to find this plant occurring in the West Indies and Oceanic islands, but not on the South-American continent. Perhaps it may be one of those plants which have been distributed by the drifting of their seeds in the sea.

C. Noronhæ, n. sp.

Planta rupicola flaccida, rhizomate brevissimo, basi dilatato Folia plura, angusta linearia acuminata debilia, circiter 18 uncias longa, $1\frac{1}{2}$ lineas lata; carina et margine scabrida. Culmi subæquilongi triquetri. Umbella radiorum 7–10 valde inæqualium patula. Bracteæ involucri 5, longæ lineares acuminatæ. Radius longissimus uncialis, basi vagina castanea. Spiculæ ad 30 in apicem congestæ, circiter $\frac{1}{4}$ unciam longæ, ferrugineæ. Rhachilla crassiuscula, alis scariosis magnis. Spiculæ sessiles in discis elevatis rotundatis. Glumæ duæ ad basin spiculæ; gluma infima lanceolata subacuta, superior latior obtusa. Glumæ alteræ lanceolatæ acutæ, ferrugineæ, carina viridis, costis elevatis 10. Stamina tria. Stylus longuisculus trifidus rufus.

Caryopsis obovata, basi angustata, obtuse trigona brevissime apiculata rufa punctata.

Main island, high up on the Peak and in clefts in the rock of Chaloupe Bay; no. 7.

CYPERUS DISTANS, *L. f. Suppl.* p. 103; *Jacq. Ic. Pl. Rar.* ii. p. 8, t. 299; *C. B. Clarke in Journ. Linn. Soc. Bot.* xxi. p. 144.

Plentiful by the edges of the roads near the Peak in the cultivated district.

Distribution. The whole of the tropical world.

C. FERAX, *Rich. in Act. Soc. Hist. Nat. Par.* i. p. 106; *C. B. Clarke in Journ. Linn. Soc. Bot.* xx. p. 295, xxi. p. 191.—Diclidium ferox, *Schrad.*; *Nees in Mart. Fl. Bras.* ii. 1. p. 54.

Common in the central district with the last, but much more abundant; Sambaquichaba, Leao, Tangle Bay, &c.

Distribution. Common in South America.

C. LIGULARIS, *L. Am. Acad.* v. p. 31; *Sp. Pl.* p. 70; *Boeck. Cyp. Herb. Berol.*; *C. B. Clarke in Journ. Linn. Soc. Bot.* xx. p. 196.

Tangle Bay, and the field below the curral near Cotton-tree Bay and Leao. Not so common as the last. Abundant on Rat Island; forming large tufts.

Distribution. All warm parts of America from Florida to Rio de Janeiro, also west Tropical Africa and Madagascar.

FIMBRISTYLIS DIPHYLLA, *Vahl.*

Scattered about on the main island, on the hill above Chaloupe Bay, at East Point near the curral, and at Leao, mostly along the paths, in dry spots. At Morro branco it was common and a good deal larger, growing among grass.

Distribution. All the tropical world.

SCIRPUS MICRANTHUS, *Vahl.*—Hemicarpha isolepis.

In the fields below the Peak and round San Antonio Fort, in waste ground.

Distribution. All tropical countries. It is a common weed in the garden paths in Pernambuco, and has doubtless been introduced accidentally into Fernando Noronha.

RHYNCHOSPORA MICRANTHA, *Vahl, Enum.*; *Boeck. Cyp. Herb. Berol.* p. 768.—Dichromena micrantha, *Kunth, Enum.* p. 278.

On the hill between Chaloupe Bay and S. Antonio Bay, on the paths through the maize-fields in the Sapate, and near the Peak.

Distribution. West Indies, Guatemala, Brazil, West Africa, and Teneriffe.

GRAMINEÆ.

PASPALUM ANEMOTUM, n. sp.

Herba dense cæspitosa. Folia copiosa, flaccida elongata, $2\frac{1}{2}$–3-pedalia vix $\frac{1}{4}$ unciam lata linearia acuminata striata, scabra; ore et marginibus vaginæ longe albo-ciliatis. Ligula brevis membranacea brunnea laciniata, laciniis rotundatis. Culmi bipedales erecti. Panicula nutans 6-uncialis, racemis circiter 20. Rhachis gracilis vix complanata. Flores per paria parvi pallidi longi. Pedicelli breves scabridi. Glumæ exteriores ovatæ obtusæ subtenues, internæ induratæ lanceolatæ. Palea indurata anceolata. Stamina 3. Antheræ castaneæ. Stigmata breviuscula atro-purpurea.

Abundant on the open ground behind Fort San Antonio, in the low ground near Tangle Rock, and at Morro branco. This is a large plant, forming thick tussocks in low-lying country; the leaves are numerous and long and narrow, the inflorescences few and rather compact, the racemes long and slender, the rhachis hardly flattened. The flowers numerous and white. It belongs to the same section as *P. virgatum*, but even in habit is distinct, the leaves and inflorescence being much narrower.

P. PHONOLITICUM, n. sp. (Plate IV.)

Herba rigida erecta, vix cæspitosa. Folia pauca erecta late linearia, culmo multo breviora, acuminata striata scabrida, 6 uncias longa, $\frac{1}{2}$ unciam lata. Ore et marginibus vaginæ albo lanatis. Ligula laciniata, laciniis rotundatis membranaceis. Culmus sesquipedalis ad inflorescentiam vaginis tectus. Panicula erecto-nutans 6-uncialis, racemis 10. Rhachis sinuata scabra vix complanata. Flores per paria in pedicellis brevibus pubescentibus quam in præcedente paullo majores. Gluma externa late ovata obtusa carinata cymbiformis . . . . plana elliptica obtusa; gluma interna indurata ovata obtusa cymbiformis minute striata. Palea elliptica obtusa striata. Antheræ flavæ. Styli atro-purpurei.

On the altered phonolite of Morro branco, growing in clefts of the rock and on the slopes.

This species is allied closely to the preceding, but is distinguished at first sight by its habit; it does not form the large long-leaved tussocks of that species, but grows in small tufts with a few erect, stiff leaves, much shorter and broader than those of the other. The whole plant, too, is smaller and more condensed.

The flowers, however, are larger, and are ovate in outline, instead of being almost lanceolate elliptic, while the glumes are deeper and more blunt, and the fertile glume and palea harder in texture.

PANICUM SANGUINALE, *L.*, var. CILIARE, *Doell, Rhein. Fl.* p. 126.—P. ciliare, *Retz. Obs.* iv. p. 16; *Kunth, Enum.* i. p. 82.

Paths of the garden at the Director's House. This was a quite typical prostrate form, similar to the Indian. Another variety, with numerous short lanceolate dark green leaves, an inch long by a quarter broad, and with geniculate stems, grew on Tobacco Point, and a more tufted dwarf form on the slopes of Morro branco.

The variety appears to be rare in Brazil, though very common in the Old World.

P. SANGUINALE, var. DISTANS, *Doell in Mart. Fl. Bras.* vol. ii. p. 134.—Digitaria horizontalis, *Willd. Enum.* i. p. 92; *Roem. & Schult. Syst. Veg.* ii. p. 474.

This is the commonest form in South America, and was very plentiful and varied here. A quite typical form occurred on Cape Placellière and on the north side of Rat Island, and again along the paths in the village. A very large and hairy form grew on the cliffs at Chaloupe Bay. It was about three feet high, with a decumbent base, and the leaf-sheaths were thickly covered with long white hairs a quarter of an inch in length. The flower-spikes also had, in the lower part, a number of similar white hairs on the rhachis, and the spikelets were pubescent. This variety was obtained also by Glocker at Bahia (no. 216 of his collection).

P. BRIZOIDES, *Lam. Ill.* i. p. 470, no. 882; *Doell in Mart. Fl. Bras.* ii. p. 184.—P. appressum, *Lam. Ill.* p. 176, no. 929.

In a damp spot in the centre of the isle and along the streams at Leao and in Sponge Bay, and also very dense and plentiful round the Lake. This plant is known here as "Gramma."

Distribution. Cosmopolitan.

P. PLANTAGINEUM, *Link, Hort. Berol.* i. p. 206; *Kunth, Enum.* i. p. 92; *Trin. in Mém. Acad. Pétersb.* 1835, p. 242; *Doell in Mart. Fl. Bras.* ii. p. 186.—P. Leandri, *Trin. Sp. Gram.* xxviii. t. 335.

Along the paths in the central district and in the maize-fields. Only a few plants, evidently introduced in crops.

Distribution. Texas, Mexico, and Brazil, from Pernambuco to Rio de Janeiro, also Bolivia and Australia.

PANICUM NUMIDIANUM, *Lam. Ill.* p. 902; *Doell in Mart. Fl. Bras.* ii. p. 188.

In the swamp by the stream at Leao, and two or three large patches on the path in the Sapate. It is called "Capim de Planta," and is, without doubt, introduced more or less intentionally, as it is the best fodder-grass in the north of Brazil and constantly cultivated.

P. FUSCUM, *Sw. Prodr.* p. 23; *Fl. Ind. Occ.* i. p. 156.—P. fasciculatum, *Nees, Agr. Bras.* p. 151.

A few scattered plants in Chaloupe Bay, in rock-clefts. In the sand of the shore of Peak Bay, and more plentiful and larger along the path into the Sapate with the preceding.

Distribution. Southern North America, West Indies, and South America.

P. TRICHODES, *Sw. Prodr.* p. 24; *Fl. Ind. Occ.* i. p. 176 (ex parte).—P. capillaceum, *Lam. Ill.* i. p. 173; *Doell in Mart. Fl. Bras.* ii. p. 249.

Plentiful on the Peak and at Tangle Rock, and is almost the only herbaceous plant growing under the bushes of the Sapate. It grows, too, on Sella Giueta. This is the plant distributed under the name of *P. parvifolium*, Lam., from the 'Challenger' Expedition collections. The species is a very common woodland plant in Brazil and other parts of South America and the West Indies; but there seems to have been some confusion as to its name. The earliest name seems to be *P. trichodes*, Sw., which was based on a plant collected by Sir Hans Sloane in Jamaica, which is preserved in the Natural History Museum. In his later work, Swartz added to the species Linnæus's *P. brevifolium*, based upon a Ceylonese plant and quite distinct.

P. COLONUM, *L. Sp. Pl.* ed. ii. p. 84; *Jacq. Eclog.* t. 32; *Doell in Mart. Fl. Bras.* ii. p. 140.

Paths on Rat Island; a purple-flowered form is common on the sandy shores of Peak Bay, and the common pale-coloured form grows all over the paths and waste ground in various parts of the main island near the village.

Distribution. A weed of world-wide distribution.

Setaria scandens, *Schrad.*; *Roem. & Schult. Syst.* ii. p. 279. —Panicum scandens, *Trin. Diss.* ii. p. 166; *Doell in Mart. Fl. Bras.* ii. p. 170.

Common in thickets on the Peak and in Chaloupe Bay, scrambling over the lower plants, also on Rat Island.

Known here as "Carapicho." There was a very tall and stout erect or suberect form, $2\frac{1}{2}$ feet high, with thick stems, growing in clefts of the rocks at Cape Placellière.

Distribution. South America, especially plentiful in Brazil.

The heads adhere tightly to clothes, &c., by means of the recurved processes on the setæ, and in this way the plant gets carried about from place to place.

S. caudata, *Roem. et Schult. Syst.* ii. p. 495.—Panicum caudatum, *Lam. Ill.* no. 893; *Doell in Mart. Fl. Bras.* ii. p. 161.

This is chiefly a woodland plant, forming in the Sapate in open spots large tussocks very like those of *Brachypodium sylvaticum*, the foliage being very plentiful and dark green. It was plentiful in the Sapate, at Tangle Rock, and on the Peak. On Sella Giueta and also on the Look-out Hill there was a smaller half-prostrate form, with geniculate culms.

The plant is called "Capinche."

Distribution. Mexico to Brazil.

Cenchrus viridis, *Spreng. Syst.* i. p. 301; *Doell in Mart. Fl. Bras.* ii. p. 309.

Among *Æschynomene hispida*, on the slopes towards the sea on the northern side of Rat Isle.

Distribution. S. America.

C. echinatus, *L. Sp. Pl.* ed. 2, p. 1150; *Doell in Mart. Fl. Bras.* ii. p. 310, t. xliii.—C. pungens, *H. B. K. Nov. Gen. et Sp.* i. tab. xliv.

On the shores of the sandy bays at Peak Bay, Portuguese Bay, Leao, Chaloupe Bay, S. Antonio Bay, and in the Sapate; common.

Distribution. Whole tropical world. A very troublesome weed, on account of its prickly burr-like spikelets.

Zea Mays, *L.*

Is extensively cultivated here, and the grain exported to Pernambuco. The husking of the maize and preparing it for export are done by the convicts. One plant we saw had no less than nine full-sized cobs upon it.

Oryza sativa, *L.*

Rice is cultivated to a small extent at Sambaquichaba.

Anthephora elegans, *Schreb. Beschreib. Graes.* ii. p. 105; *Doell in Mart. Fl. Bras.* ii. p. 313.—Tripsacum hermaphroditum, *L. Sp. Pl.* ed. 2, p. 1378.—Cenchrus lævigatus, *Trin. Fund. Agrost.* p. 172.

Tolerably plentiful on the sandy ground behind Fort San Antonio, also near the Sapate.

Distribution. Tropical America.

A common weed in the grass-plots in Pernambuco.

Saccharum officinarum, *L. Sp. Pl.* ed. 1, p. 54.

The sugar-cane is largely cultivated in the main island.

Andropogon Schœnanthus, *L.*?

A tuft of a very sweet-scented grass was found in a corner of a maize-field, where I believe it had been planted. There was no flower on it, but it apparently belonged to this species.

Sorghum vulgare, var. saccharatum?

A few plants occurred in a maize and sugar-cane field near Sambaquichaba.

S. halepense, *Pers. Syn.* p. 101; *Doell in Mart. Fl. Bras.* ii. 2. p. 272.—Holcus halepensis, *L. Sp. Pl.* ed. 2, p. 1047.

A weed in the garden of the Director's house, and forming dense thickets on the slopes of Peak and Water Bay below the village. Also found on Rat Island.

Eleusine indica, *Gaertn. Fruct.* i. p. 8.—Cynosurus indicus, *L. Sp. Pl.* ed. 2, p. 106, no. 8; *Doell in Mart. Fl. Bras.* ii. 2. p. 86, t. xxiv.

A weed in the garden, and also exceedingly abundant among the stones of the paths throughout the main island. It seems to be the only plant that forms anything like turf here. It also grows on Rat Island.

Distribution. All warm countries.

E. cruciata, *Lam. Ill.* t. 48. fig. 2.—Dactyloctenium ægyptiacum, *Willd. Enum.* ii. p. 1029; *Doell in Mart. Fl. Bras.* ii. p. 38, t. xxv.

Three forms of this common plant occur here:—The typical suberect form, with the leaves almost glabrous; abundant in waste ground in the village, &c., also on Rat Island. A tall, erect, but weak form, with flaccid, very hispid leaves; a single

plant on Platform Island. And a flat prostrate plant, with short broad leaves and short blunt spikes, which is very plentiful on the roads near Sambaquichaba and Fort San Antonio. Doell, in the 'Flora Brasiliensis,' describes the leaves of this species as "glabra vel glabriuscula"; but most of the Brazilian specimens I have seen have distinctly hairy leaves with numerous white cilia.

Distribution. The whole of the warm parts of the world.

CHLORIS BARBATA, *Sw. Fl. Ind. Occ.* i. p. 200; *Doell in Mart. Fl. Bras.* ii. pt. 3, p. 67; *Steud.* p. 204.

Common grass, growing between the stones of the walls and paths, also plentiful in the Sapate and in Chaloupe Bay, where it attains the height of five feet.

Distribution. World-wide.

C. VIRGATA, *Sw. Fl. Ind. Occ.* i. p. 203; *Roem. & Schult. Syst.* ii. 6. p. 8; *Doell in Mart. Fl. Bras.* ii. p. 65, t. xviii.

Along the paths in the Sapate. Also as tall as the preceding and growing with it in Chaloupe Bay. In Sponge Bay there was a smaller prostrate form.

Distribution. West Indies and Brazil.

GYMNOPOGON RUPESTRE, n. sp.

Herba rigidula ad 1½-pedalis. Culmi plures graciles ferme ad inflorescentiam foliati. Folia dissita linearia erecto-patula, 4–5 uncias longa, ⅛ unciam lata, acuminata pubescentia. Vaginis 1½-uncialibus, ligula et marginibus vaginæ albo ciliatis. Rhachis tenuis breviuscula, spicæ dissitæ tenues ad basin albo pubescentes, ferme 3-unciales, pallidæ. Glumæ inferiores angustæ lineares acutæ, scabridæ. Gluma fertilis ad basin pubescens, pilis albidis, anguste lanceolata. Arista longa scabra. Gluma terminalis angustissime linearis, caryopsis linearis brunnea. Rhachilla producta scabrida, flore sterili gluma vacuo, basi pilosa, sistente.

This grass was tolerably abundant in Portuguese Bay, growing on the cliffs in tufts with *Hyptis suaveolens.* It also occurred along the woodcutters' track in the Sapate, and on the summit of Tangle Rock.

ERAGROSTIS CILIARIS, *Link, Hort. Berol.* p. 192.—Poa ciliaris, *L. Syst.* ed. 10, p. 82, n. 590.

Plentiful along the paths and on the rocks near the village, and at Leao, at the Sapate, and on the Peak. Also on the paths in Rat Island.

Distribution. All warm countries, but especially abundant in Brazil.

ARUNDO DONAX, *L.* ?

An introduced grass at Leao, without flowers.

GUADUA LATIFOLIA, *Kunth, Syn.* i. p. 254 ?

What appears to be this common Brazilian Bamboo has been introduced here, in a few places, but it was not in flower.

CRYPTOGAMIA.

PELLÆA GERANIÆFOLIA, *Fée, Gen. Fil.* p. 130; *Hook. & Bak. Syn. Fil.* p. 146.—Pellæa concolor, *Bak. in Mart. Fl. Bras.* i. p. 396, t. xliii. fig. 3.

Under rocks in damp spots on the Peak and on Tangle Rock. This was the only Fern seen, and it is very local. The dryness of the climate is evidently unsuited for ferns.

CHARACEÆ.

NITELLA CERNUA, *A. Br., in Monatsber. Berl. Akad.* 1858, p. 354.

The lake was almost entirely filled with this beautiful *Nitella*, which formed a solid mass. I am indebted to Mr. H. Groves for identifying it.

Distribution. Caraccas.

MUSCI.

By A. GEPP, M.A., F.L.S.

CALYMPERES RICHARDI, *C. Muell.*

Hab. On bark in the Sapate; fruiting specimen on rocks above Point Noir. Also obtained by Darwin ('Beagle' Expedition).

TORTULA, sp.

Hab. Cleft in the Peak.

TORTULA, sp.

Hab. On the ground, Morro branco.

HYPNUM, sp.

Hab. On a stone in the Sapate.

HYPNUM, sp.

Hab. On a stone in the Sapate.

HEPATICÆ.

RICCIA RIDLEYI, *Gepp*, n. sp.

R. fronde solida crassa dichotoma, laciniis obovato-oblongis canaliculatis, margine squamoso subtus membrana purpurea obsito,

squamis imbricatis rotundatis ultra marginem paulum exstantibus purpureis margine pallido.

Hab. loco humido umbroso Tangle Rock, Insula Fernando Noronha (*H. N. Ridley*, Aug. 1887).

Dimensions of frond, 5×2; spore $0{\cdot}1 \times 0{\cdot}6$ mm.

This species falls into the scale-bearing section of Bischoff's subgenus *Lichenoides*. It most resembles *R. limbata*, Bischoff, but differs in the less acute, non-ascending margin of the thallus, the colourless border of the scales, and the direction, which is at right angles to the margin of the thallus. The scales spring from the purple membrane, which covers the underside of the thallus for about one half of the distance from the margin to the median line, and exhibits obscure transverse folds. The scales are expanded laterally so as to overlap one another in an imbricate manner. The laciniæ are emarginate, devoid of papillæ, and still united to the withered main thallus; they bear the fruit beneath the upper surface in the median groove. Several archegonia, but only one ripe fruit has been observed. Several minute closely involute thalli occur beneath the older plants. The latter are aggregated together, and are very firmly attached to the soil by innumerable short hairs.

ALGÆ.

By George M. Murray, F.L.S.

The Algæ collected by the 'Challenger' Expedition at Fernando Noronha and recorded by the late Professor Dickie (Linn. Soc. Journ. Bot. vol. xiv. p. 363) have been included for the purpose of completing the enumeration of Algæ from this island.

Florideæ.

Centroceras clavulatum, *J. Ag.*
Ridley, Lea, and Ramage!
Geogr. Distr. Throughout tropical and subtropical seas.

Gigartina Teedii, *Lam.*
Ridley, Lea, and Ramage!
Geogr. Distr. Atlantic and Mediterranean.

Chrysymenia enteromorpha, *Harv.*?
'Challenger.'
Geogr. Distr. West Indies.

Peyssonnelia Dubyi, *Crouan.*
'Challenger.' *Ridley, Lea, and Ramage*!
Geogr. Distr. Atlantic.

Gracilaria multipartita, *Clem.*
'Challenger.'
Geogr. Distr. Tropical and subtropical Atlantic, Mediterranean, Indian Ocean, N. Zealand.

G. armata, *Ag.*?
'Challenger.'
Geogr. Distr. Mediterranean.

Galaxaura cylindrica, *Lamx.*
'Challenger.' *Ridley, Lea, and Ramage*!
Geogr. Distr. West Indies and Red Sea.

G. rugosa, *Lamx.*
'Challenger.' *Ridley, Lea, and Ramage*!
Geogr. Distr. Tropical Atlantic and Indian Ocean.

G. lapidescens, *Sol.*
Ridley, Lea, and Ramage!
Geogr. Distr. Tropical Atlantic, Pacific and Indian Oceans.

G. oblongata, *Lamx.*
'Challenger.'
Geogr. Distr. Tropical Atlantic.

Zanardinia marginata, *J. Ag.*
'Challenger'! *Ridley, Lea, and Ramage*!
Geogr. Distr. Tropical Atlantic, Indian Ocean, Australia.

Laurencia papillosa, *Forsk.*
Ridley, Lea, and Ramage!
Geogr. Distr. Throughout tropical seas.

L. scoparia, *J. Ag.*
Ridley, Lea, and Ramage!
Geogr. Distr. Tropical Atlantic (America).

Acanthophora Thierrii, *Lamx.*
'Challenger.' *Ridley, Lea, and Ramage*!
Geogr. Distr. Tropical Atlantic.

A. multifida, *Lamx.*
Ridley, Lea, and Ramage!
Geogr. Distr. Tropical Atlantic.

AMANSIA DUPERREYI, *Ag.*
'Challenger.'
Geogr. Distr. Martinique.

LITHOTHAMNION MAMILLARE, *Harv.*
'Challenger'! *Ridley, Lea, and Ramage*!
Geogr. Distr. Atlantic (Bahia to Tierra del Fuego), Africa (Cape Verde).

L. POLYMORPHUM, *Aresch.*
Ridley, Lea, and Ramage!
Geogr. Distr. Throughout all seas.

JANIA CUBENSIS, *Mont.*
'Challenger'!
Geogr. Distr. West Indies.

J. RUBENS, *Lamx.*
Ridley, Lea, and Ramage!
Geogr. Distr. Throughout all seas.

CORALLINA CERATOIDES, *Kuetz.*
'Challenger'! *Ridley, Lea, and Ramage*!
Geogr. Distr. Atlantic.

PHÆOPHYCEÆ.

ASPEROCOCCUS INTRICATUS, *J. Ag.*
'Challenger'!
Geogr. Distr. West Indies.

DICTYOTA CILIATA, *J. Ag.*
'Challenger'!
Geogr. Distr. West Indies.

D. DICHOTOMA, *Huds.*
Ridley, Lea, and Ramage!
Geogr. Distr. Atlantic and New Zealand.

D. BARTYRESIANA, *Lam.*
'Challenger'!
Geogr. Distr. West Indies.

ZONARIA LOBATA, *Ag.*
Ridley, Lea, and Ramage!
Geogr. Distr. Atlantic (Cape of Good Hope to Canaries and Brazil).

PADINA PAVONIA, *L.*
'Challenger.' *Ridley, Lea, and Ramage*!
Geogr. Distr. Throughout warm seas.

HALYSERIS JUSTII, *Lamx.*
Ridley, Lea, and Ramage!
Geogr. Distr. West Indies.

H. DELICATULA, *Lamx.*
'Challenger'! *Ridley, Lea, and Ramage.*
Geogr. Distr. Atlantic (America from Mexico to Brazil).

H. PLAGIOGRAMMA, *Mont.*
'Challenger'!
Geogr. Distr. Atlantic (America from West Indies to Brazil) and Pacific (Sandwich Islands).

SARGASSUM VULGARE, *Ag.*
'Challenger'! *Ridley, Lea, and Ramage!*
Geogr. Distr. Tropical and South subtropical Atlantic.

CHLOROPHYCEÆ.

BRYOPSIS PENNATA, *Lamx.*
Ridley, Lea, and Ramage!
Geogr. Distr. West Indies (Indian Ocean?).

CODIUM TOMENTOSUM, *Ag.*
Ridley, Lea, and Ramage!
Geogr. Distr. Throughout tropical and temperate seas.

HALIMEDA OPUNTIA, *Lamx.*
'Challenger.'
Geogr. Distr. Throughout tropical seas.

VALONIA FILIFORMIS, *Dickie.*
Ridley, Lea, and Ramage!
Geogr. Distr. Mauritius.

V. VENTRICOSA, *J. Ag.*
Ridley, Lea, and Ramage!
Geogr. Distr. West Indies.

Webster, in 'Voyage to the Southern Ocean in H.M.S. 'Chanticleer,'' vol. ii. p. 337, gives a description of "clusters of vesicles" which he cannot determine as animal or vegetable. The description obviously applies to *Valonia ventricosa*, even to minute details. He describes only one other seaweed from Fernando Noronha. It had "the aspect of a land plant, leaves linear, pinnate, an inch in length, and of a very bright green." This would apply to either a *Caulerpa* or a *Bryopsis*.

CHAMÆDORIS ANNULATA, *Mont.*
Ridley, Lea, and Ramage!
Geogr. Distr. Tropical Atlantic and Indian Ocean.

CAULERPA PROLIFERA, *Lamx.*
Ridley, Lea, and Ramage!
Geogr. Distr. Tropical and subtropical Atlantic and Mediterranean.

C. TAXIFOLIA, *Ag.*
Ridley, Lea, and Ramage!
Geogr. Distr. West Indies (Pacific? Australia?).

C. CUPRESSOIDES, *Ag.*, var. ALTERNIFOLIA, *Crouan.*
Ridley, Lea, and Ramage!
Geogr Distr. West Indies.

C. CLAVIFERA, *Ag.*
'Challenger.' *Ridley, Lea, and Ramage*!
Geogr. Distr. Throughout tropical seas.

C. MEXICANA, *Sond.*
'Challenger.'
Geogr. Distr. Tropical Atlantic.

ENTEROMORPHA COMPRESSA, *Grev.*
Ridley, Lea, and Ramage!
Geogr. Distr. Cosmopolitan.

ENTEROMORPHA, sp.?
'Challenger.'
Geogr. Distr.

KALLONEMA OBSCURUM, *Dickie.*
'Challenger.'
Geogr. Distr. Known only from Fernando Noronha.

ULVA LACTUCA, L.
Ridley, Lea, and Ramage!
Geogr. Distr. Cosmopolitan.

U. LOBATA, *Kuetz.*
'Challenger.'
Geogr. Distr. Atlantic.

CLADOPHORA SUBVARICOSA, *Dickie.*
'Challenger'!
Geogr. Distr. Known only from Fernando Noronha.

C. MINUTA, *Dickie.*
'Challenger.'
Geogr. Distr. Known only from Fernando Noronha.

CLADOPHORA MORRISIÆ, *Harv.*
Ridley, Lea, and Ramage!
Geogr. Distr. North America.

CHÆTOMORPHA ANTENNINA, *Kuetz.*
Ridley, Lea, and Ramage!
Geogr. Distr. West Indies, South America, and India.

LYNGBYA NORONHÆ, *Dickie.*
'Challenger'!
Geogr. Distr. Known only from Fernando Noronha.

HORMOSPORA PELLUCIDA, *Dickie.*
'Challenger'!
Geogr. Distr. Known only from Fernando Noronha.

There are two imperfect specimens of *Cladophora* and several *Cyanophyceæ* in a condition which would not justify my assigning them names.

FUNGI.

By GEORGE M. MURRAY, F.L.S.

BASIDIOMYCETES.

LEUZITES ERUBESCENS, *Berk.*
Ridley, Lea, and Ramage!
Geogr. Distr. Rio de Janeiro.

SCHIZOPHYLLUM COMMUNE, *Fr.*
Ridley, Lea, and Ramage! Cape Placellière woods.
Geogr. Distr. Throughout the world, but never common.

POLYPORUS LUCIDUS, *Fr.*
Ridley, Lea, and Ramage! On a stump in the Sapate.
Geogr. Distr. Cosmopolitan.

P. HIRSUTUS, *Fr.*
Ridley, Lea, and Ramage! On a *Sapium* in the Sapate.
Geogr. Distr. Cosmopolitan.

P. FOMENTARIUS, *Fr.*
Ridley, Lea, and Ramage! Common on Cape Placellière in one or two spots.
Geogr. Distr. Europe, Asia (Siberia and Penang), and North America.

EXIDIA GLANDULOSA, *Fr.*
Ridley, Lea, and Ramage! Sapate woods.
Geogr. Distr. Europe, N. Asia, N. America, S. Africa, Australia, and Tasmania.

CYATHUS STRIATUS, *Hoffm.*
Ridley, Lea, and Ramage! Sapate woods.
Geogr. Distr. Europe, N. America, and Tropical Africa.

PYRENOMYCETES.

CLAVICEPS PURPUREA, *Tul.*
Ridley, Lea, and Ramage!
On *Cenchrus echinatus* in the coco-nut plantation, Sueste.
Geogr. Distr. Europe, North America, and N. Zealand.

DOLDINIA CONCENTRICA.
Ridley, Lea, and Ramage! Sapate woods.
Geogr. Distr. Cosmopolitan.

USTULINA VULGARIS, *Tul.*
Ridley, Lea, and Ramage!
Geogr. Distr. Europe, America, Ceylon.

XYLARIA POLYMORPHA, *Grev.*
In the Sapate woods on rotten trees.
Geogr. Distr. Whole world.

DIATOMACEÆ.

By JOHN RATTRAY, M.A., B.Sc.
(Communicated by H. N. RIDLEY, M.A., F.L.S.)

The following list of *Diatomaceæ* must be regarded as giving but a very imperfect conception of this department of the flora of Fernando and, indeed, of the collections made during the present Expedition. The materials entrusted to me for examination by Mr. H. N. Ridley consisted of:—a few small samples of calcareous Algæ, chiefly *Lithothamnion* and *Galaxaura*, in the dry state; similar but larger samples of the same genera preserved in spirit along with other *Chlorophyceæ* and *Rhodophyceæ*; a small sample of sediment from various gatherings, also in spirit; and dried specimens of *Ceramia* with shell-fragments. Two samples of guano from Rat Island off Fernando Noronha were also examined, and the species observed in these are given in a separate list. No surface-gatherings, which might be expected to yield many *Chætocerotidæ*, *Rhizosoleniæ*, and *Coscinodisci*, such as are abundant on the opposite shores of Africa and in the Gulf of Guinea, were taken.

Fam 1. Cymbelleæ.

1. Amphora marina, *W. Sm.*=A. lineolata, *Kuetz.*

Specimens similar to that in Schmidt's Atl. d. Diatk. pl. xxvi. fig. 81, and approaching *A. acutiuscula*, Kuetz. Rare.

2. Cymbella obtusa, *Greg.* (?).

Girdle aspect only observed. Length ·03 mm.; breadth ·006 mm. Markings 6 to 8 in ·01 mm. Rare.

3. C. amphicephala, *Naeg.*

Length ·02 mm.; breadth ·006 mm. Rare.

4. Cocconema, sp.?

Close to *C. australicum*, A. Schmidt. One fragment.

Fam. 2. Naviculeæ.

5. Navicula laciniosa, *A. Schmidt.*

Similar to Java specimens, but the extremities slightly more acute. Length ·02 mm.; breadth at widest areas ·0075 mm. Few.

6. N. subula, *Kuetz.*, var. *Grun.* (Ver. Wien. Ak. 1860, p. 548, pl. i. fig. 24).

Length ·0375 mm.; breadth ·005 mm. Rare.

7. N. cocconeiformis, *Kuetz.*

Length ·015 mm.; breadth ·0075 mm. Rare.

8. N. mutica, *Kuetz.*

Length ·015 mm.; breadth ·0075 mm. Few.

9. N. Weissflogii, *A. Schmidt.*

Similar to specimens from Sandwich Islands. Length ·0175 mm.; breadth ·0075 mm. Rare.

10. N. sp.?

Length ·0875 mm.; breadth ·0085 mm. Markings not visible owing to the presence of detritus. One specimen.

11. N. brasiliensis, *Grun.*

Length ·025 mm.; breadth ·0175 mm. Few.

12. N. minuscula, var. bahusiensis, *Grun.*

Length ·025 mm. Markings obscure. Fragmentary. One specimen.

13. N. erythræa, *Grun.*

Length ·08 mm.; breadth at middle ·0325 mm. Striæ 8 in ·01 mm. Rare.

14. NAVICULA INTERRUPTA, *Kuetz.*, var.

Length ·08 mm.; breadth of central portion ·02 mm., of lobes ·03 mm. Rare.

15. PLEUROSIGMA SPECIOSUM, *W. Sm.*, var.

Similar to Tahiti specimens procured by H.M.S. 'Challenger.' Length ·1225 mm.; breadth ·025 mm. Several.

16. P. LORENZII, *Grun.*

Similar to specimens found by Dr. Lorenz in 2 to 4 fathoms on *Zostera*-ground in the Adriatic. Length ·1 mm.; breadth ·02 mm. Few.

Fam. 3. ACHNANTHEÆ.

17. ACHNANTHES SUBSESSILIS, *Ehrenb.*

Length ·045 mm. Rare.

18. A. GLABRATA, *Grun.*

Typical. Rare.

Fam. COCCONEIDEÆ.

19. COCCONEIS SCUTELLUM, *Ehrenb.*

Major axis ·02 mm., $1\frac{3}{5}$ times minor. Not uncommon.

Fam. 4. FRAGILARIEÆ.

20. SYNEDRA AFFINIS, var. HYBRIDA, *Grun.*

Length ·1025 mm.; breadth ·0125 mm. Striæ 12 to 13 in ·01 mm. This var. is allied to *S. tabulata*, Kuetz., and *S. nitzschioides*, Grun.

21. S. AFFINIS, var. DELICATULA, *Grun.*

Length ·0625 mm.; breadth ·005 mm. Specimens found attached laterally. Common.

22. S. OXYRHYNCHUS, *Kuetz.*

Length ·0625 mm.; breadth ·006 mm. Rare.

23. S. ACUS, *Kuetz.*

Length ·0625 mm.; breadth ·005 mm. Rare.

24. S. LANCEOLATA, *Kuetz.*

Length ·075 mm.; breadth ·01 mm. Few.

25. LICMOPHORA AUSTRALIS, *Grun.*, var. MAJOR.

Length ·0425 mm.; breadth ·025 mm. Rare.

26. L. DEBILIS, *Grun.*=Podosphenia debilis, *Kuetz.*

Length ·0225 mm.; breadth ·0125 mm. Few.

27. L. PARADOXA, *Ag.*=Diatoma flabellatum, *Juerg.*, et Gomphonema paradoxum, *C. Ag.*

Length ·04 mm.; breadth ·035 mm. Few.

28. Licmophora Lyngbyi, var. longa, *Grun.*
Length ·2625 mm.; breadth ·05 mm. One specimen observed.

Fam. 5. Tabellarieæ.

29. Grammatophora marina, var. intermedia, *Grun.*
Concatenate. Common.

30. G. angulosa, var. hamulifera, *Grun.*
Similar to specimens from Valparaiso. Length ·015 mm.; breadth ·0175 mm. Several.

31. G. japonica, *Grun.*
Length ·065 mm.; breadth ·0125 mm. Concatenate. Rare.

Fam. 6. Surirelleæ.

32. Nitzschia marginulata, var. subconstricta, *Grun.*
Length ·0625 mm.; breadth at median constriction ·0175 mm., at lobes ·02 mm. Rare.

33. N. lanceolata, *W. Sm.*
One fragment.

34. N. marina, *Grun.*
Length ·13 mm.; breadth ·0125 mm. Few.

35. N. fluminensis, *Grun.*
Similar to Campeachy Bay specimens. Length ·12 mm.; breadth ·01 mm. Rare.

Fam. 7. Chætocerotidæ.

36. Rhizosolenia styliformis, *Brightw.*
Calyptriform extremity only observed. One specimen.

Fam. 8. Melosireæ.

37. Melosira nummuloides, *Ag.*
Concatenate. Abundant.

Fam. 9. Biddulphieæ.

38. Biddulphia pulchella, *Gray.*
Concatenate. Common. In the same chain a frustule ·125 mm. long had not divided, whilst the second from it, of the same length, showed the division complete. The breadth of the girdle before division is about ·0625 mm. Abundant.

39. B. mobiliensis, *Grun.*=B. Baileyi, *W. Sm.*
Common on the Rhodophyceæ. Not associated with the foregoing.

40. Triceratium Favus, *Ehrenb.*
One fragment observed on *Ceramium rubrum.*

41. T. elegans, *Grev.* = T. Hardmanianum, *Witt.*
Diam. ·04 mm. Rare.

42. T. alternans, *Ehrenb.*
3-sided, each side with two equal concavities. Diam. ·03 mm. One specimen.

43. T. pentacrinus, *T. Wallich.*
4-sided var. Diam. ·0675 mm. One specimen.

Fam. 10. Coscinodisceæ.

44. Coscinodiscus anguste-lineatus, *A. Schmidt.*
Diam. ·0325 mm. Markings 6 in ·01 mm. Few.

45. C. denarius, *A. Schmidt.*
Diam. ·0875 mm. Several.

46. C. minor, *Ehrenb.*
Diam. ·045 mm. Rare.

GUANO SPECIMENS.

Fam. 1. Biddulphieæ.

1. Triceratium Favus, *Ehrenb.*
Side ·1625 mm. long. Rare.

2. T. trisulcum, *Bailey.*
Side about ·25 mm. long. One specimen.

Fam. 2. Eupodisceæ.

3. Auliscus cælatus, var. strigillata, *A. Schmidt.*
Major axis ·09 mm., minor ·0825 mm. One specimen.

Fam. 3. Heliopelteæ.

4. Actinoptychus splendens, *Ralfs.*
Diam. ·12 mm. One specimen.

Fam. 4. Coscinodisceæ.

5. Arachnoidiscus Ehrenbergii, var. californica, *A. Schmidt.*
Diam. ·24 mm. One specimen.

6. Coscinodiscus biangulatus, *A. Schmidt.*
Diam. ·15 mm. Several.

7. Coscinodiscus heteroporus, *Ehrenb.*
Diam. ·14 mm. A very small central space, the markings largest around the centre and at about $\frac{2}{5}$ of the radius from it, beyond this diminishing on a somewhat wide zone to the lower.

8. C. marginatus, *Ehrenb.*
Diam. ·095 mm. Several.

9. C. perforatus, *Ehrenb.*
Diam. ·125 mm. Markings increasing slightly outwards to 3 in ·01 mm. Small on a narrow band within the border.

10. C. intumescens, *Pant.* (?).
Diam. ·0875 mm. Rare.

11. C. oculus-iridis, *Ehrenb.*
Diam. ·2 mm. Few.

12. C. argus, *Ehrenb.*
Diam. ·1125 mm. Rare.

13. C. radiatus, var. media, *Grun.*
Diam. ·1075 mm. Few.

14. C. robusta, *Grev.*
Diam. ·0875 mm. Rare.

15. C. asteromphalus, *Ehrenb.*
Diam. ·25 mm. Rare.

GEOLOGY,

Based on Petrological Notes by Thomas Davies, F.G.S.
(Communicated by H. N. Ridley, M.A., F.L.S.)

The whole cluster of islands now above water only presents two groups of igneous rocks, viz. phonolites and basalts, to which must be added, by way of sedimentary rocks, some raised coral-reefs and some sandstone formed of blown sand.

The phonolite is confined to Sella Giueta, the Peak, Look-out Hill, Tangle rock, Morro branco, the Central Knoll, and the island known as the Frade; but at Sponge Bay, on the south-east side of the Main Island, are some beds of phonolitic tuffs traversed by dykes.

It is usually rudely columnar, with the columns generally forming an angle with the horizon; but on the Central Knoll they

are erect. Near Tangle Rock are horizontal columns so regular that Mr. Ramage found in one spot a complete tunnel through the mass formed by one or two having fallen out.

Morro branco ("the white hill") is a dome-shaped hill of a white rock, very different in appearance to the normal phonolite and somewhat resembling some specimens of the tuffs near Sponge Bay. It appears to have been altered by contact with basalt. A boulder of similar rock was cut through at Leao Bay by the convicts, who were making a road there. On Morro branco were found several plants which grew only here and on the similar rock of Look-out Hill, and one species of grass was peculiar to the former spot.

Not only at Morro branco but on the western cliffs beyond the peak at Boldro we found phonolite rocks altered by contact with basalt, evidencing the fact that the phonolite was anterior to the basalt. It seems, in fact, to form a groundwork of the island, covered in part with later deposits of basalt, through which project the high hills and peaks.

In Sella Giueta and Tangle Rock were strata of a muddy chert passing into a form of semiopal. This appears to be the residue of hot siliceous springs, and must have been deposited between the pouring out of one layer of phonolite and the next. In one specimen is the mould of a very large crystal, apparently of calcite. From this rock, which appears to have been laid down horizontally, it may be gathered that the phonolite was not originally injected into older rocks and then elevated above the surface, the older rocks being weathered away, but rather that it was poured out at intervals between which the hot springs deposited their silica on the cold or cooling phonolites, which was afterwards covered with another layer of the phonolites.

Basaltic Rocks.

The larger part of the islands now consists of these rocks, which occur in the forms of columnar or spheroidal basalt, in layers or dykes, scorias, pumice, tuffs, volcanic agglomerates. In Rat Island the basalt rises from sea-level at the western end, where it is capped with raised reef, to high vertical cliffs; though chiefly consisting of the ordinary fine-grained olivine basalt of the island, here and there, at the isthmus which connects the eastern promontory with the main part of the island, vesicular and amygdaloidal

basalt tuffs and scoriaceous rock from the top of a lava-flow were obtained. Passing west from Rat Island the basalt is almost entirely submerged till Platform Island (San José). This island is about 76 feet in height and crowned with reef-rock and some indurated sand-rock resembling quartzite. There are two smaller detached rocks of columnar basalt on the N.W. side.

San José is connected with the mainland by a low ridge covered with pebbles, bare at very low tides, the remains apparently of a peninsula of which Morro do Chapeo, a small rock about 12 feet in height capped with raised reef, is all that is left above sea-level. Between this rock and the Main Island were a number of large boulders of very hard basalt, containing "bombs" or balls of olivine, enstatite, and augite, much resembling those of the Laacher See, and very fresh in appearance.

In the Main Island the basalt appears in the western extremity or almost at sea-level and rises gradually towards the east hills, and after forming the great plateau of the Central district passes away into Cape Placellière and Point Noir, in the western and north-western ends of the isle. It occurs in the form of horizontal layers at Tobacco Point, and round the lake, at Boldro and elsewhere, and in some spots, especially at the last-mentioned place, it was not difficult to find the bands of scoriaceous and pumiceous rock which had formerly formed the upper layer of a lava-flow, which had again been covered by another and another lava-deposit. The basalt here, again, was rich in olivine and augite, and the prevailing rock was fine-grained, black, and compact. Besides these layers were other masses, columnar in structure, the columns being usually larger than those of the phonolite. They were very well seen in Portuguese Bay. At other spots, as at Sponge Bay, East Hills, and Tangle Rock, the basalt was in spheroids, sometimes of immense size. Near Tangle Rock they were much decomposed and altered, and showed the presence of much iron.

Dykes.—Dykes of basalt occurred in several parts of the island. At Sponge Bay they are numerous, running down from the East Hills into the sea; here they traverse beds of phonolitic tuffs, and some are as much as three feet in thickness; they are often transversely columnar, and curved and even branched. Similar dykes occur in Leao Bay, here running north, and on the north side of the island, near Cape Placellière, where they run north-east, traversing beds of scoria. They are here of considerable height,

sometimes, in fact, the whole height of the cliff, but are not very broad.

Scorias, Pumices, and Tuffs.

At the eastern end of the island is a large quantity of a red clayey soil, covered in part by some sand-dunes, and apparently overlying the ordinary basalt. This appears to be a scoriaceous basalt which has been much altered by the action of acid vapours. Another large band, harder in texture, runs from the low hills on the south of the road from San Antonio to Chaloupe Bay, where it crops out between two masses of basaltic rocks; it is of considerable depth and 100 yards in width. The central plateau of the island is covered also with a somewhat similar red clay-like deposit, which is very fertile and thickly covered with fodder-plants &c. This appears to be a ferruginous scoriaceous rock, probably poured out from a volcano in the form it is at present, and not the product of decomposition of basalt, as it at first appears.

At Look-out Hill, Boldro, and other places where the basalt comes in contact with the phonolite and has not been much compressed, it was loose in texture and frequently amygdaloidal, with zeolites.

Between Morro branco and Point Noir was a very interesting series of volcanic rocks. After passing the lake, which is surrounded by a high semicircle of cliffs of basalt arranged in layers, we come to a promontory consisting of an immense barren mass of large fragments of basalt, irregular in size and shape and piled on the top of each other to a great height above the sea. They appear to be broken columns of fine-grained basalt, and are known as Pedras Pretas (the Black Rocks). Beyond these is an indentation terminated at the west by Cape Noir, a black cape of basalt. Between the Cape and Pedras Pretas is a steep slope, about 700 feet high, consisting of a thick bed of scoria, in the shape of rolled balls overlain by a thick bed of basalt in layers. The scoria-bed was not flat, but was steeply sloped from the top of the hill to the level of the sea, the basalt following the curve. Here, we had no doubt, was a bed of ash and scoria thrown out at the first eruption of a volcano at no great distance from Cape Placellière, which still retained the slope at which they eventually settled when falling from the crater and were then covered by the flows of lava which followed this first eruption, and which has preserved

the ash-beds from destruction and denudation to the present day. The centre of the promontory which ends in Cape Placellière consists at the top of a bluish, rather loose-textured basalt; but the dense thickets and woods here make the geology difficult to see. On the north side of the Sapate, however, we come again to scoria-beds in the cliffs traversed, as above mentioned, by basalt dykes; and at Cape Placellière itself we found scoriaceous rocks, with volcanic agglomerates, pumices, and other loose-textured lavas, which seem to confirm the theory of an important crater having formerly existed in the neighbourhood. The Cape itself, however, appears to be basalt, and we were unable to trace any remains of a crater in this direction. One can only suggest from the angle at which the bed of scoria above mentioned lies that the crater from which they were ejected was somewhere to the N.E. of Cape Placellière.

Mr. Ridley writes:—"In one spot on this side of the island we found a cavern eaten out by the sea; its walls were formed by two dykes traversing the scoria-beds; the softer scoria had been removed by the sea up to a certain height, forming a small cave; I mention this because I believe it to be the origin of the Hole in the Wall that pierces Cape Placellière, which was some distance beyond this. We were unable to reach the Hole because of the great difficulty of getting there by land, though we made several attempts; nor were we able to reach it by sea on account of having no boats. Cape Placellière consists of a narrow high wall of basalt, scoria, and pumiceous and tufaceous rocks, running almost due north, the base of which is of some thickness, and the top a narrow broken edge. As far as we could make out from the nearest point we could reach, a dyke runs half across the entrance to the Hole on the eastern side.

"Sand occurs in several of the larger bays, chiefly on the north side; but in Peak Bay we were informed that during the winter months, when the current sets this way from the north, all this sand is removed, and the large basalt boulders underlying it are uncovered. At certain spots and at certain times black sand is found on the shore; this seems to be produced by the washing-out of the lighter grains of quartz and fragments of shells &c., so that only the heavier hornblende and magnetite crystals and grains are left."

Above S. Antonio Bay are extensive sand-hills, the sand being drifted up by the wind from the south. In some spots it was

cemented together by carbonate of lime from decomposition of shells, and on the top of San José we found some masses of a hard quartzite-like sandstone, apparently formed of blown sand and including a *Corbula* and a *Venus*, neither species met with elsewhere. In this rock also was a pseudomorph of apparently a felspar crystal, about an inch long, consisting of pure white translucent quartz. There was not much of this rock, and it is quite possible that it might not belong to the island.

Salt crystallizes out here and there on San José Island and elsewhere, from evaporation of sea-water; and calcite coats the raised coral-reef at Tobacco Point, and perhaps is the cementing material which in some spots of Peak Bay forms the pebbles of the beach into a conglomerate. It also lines and fills up cracks and fissures in the softer basaltic rocks at Cotton-tree Bay and in the phonolitic tuffs at Sponge Bay.

General Summary.

From these Notes it will be seen that the islands are, as has been constantly affirmed, of volcanic origin, and further that we can trace two distinct periods in their history, the phonolitic and the basaltic periods; that the phonolite was ejected in the form of phonolitic lavas and tuffs, and that there were periods of cessation of action between the eruptions, during which some hot spring deposited beds of silica. After this had happened, and perhaps at a much later date, and after much denudation had taken place, craters in the north-west and south-east portions of the island ejected scorias, pumices, tuffs, and basalt, which covered a great portion of the phonolitic rocks and altered them where it came in contact with them. At a later period, probably when volcanic action had ceased, portions of the submerged basalt beds became covered with a thick deposit of coral-reef, sometimes 100 feet in thickness, which was perhaps gradually raised above sea-level to a height of from 3 to 4 to 100 feet, and which, in some spots, having been used by the sea-birds for many years as a resting- and probably as breeding-places, became covered with a deep layer of guano, on which a rich vegetation soon established itself. All volcanic action seems to have ceased for many years, there are no traditions of tidal waves or earthquakes, and the early discoverers, nearly 400 years ago, noticed no signs of volcanic activity, such as were visible at that time in the Canary Islands. Much denudation and destruction has without doubt occurred,

but the soundings which have been taken round the island are insufficient to give us any clear idea of its original size. At a short distance on each side of the group, the depth suddenly increases to over 2000 feet.

Some American petrologists, who have found similar rocks to those of Fernando do Noronha in the neighbourhood of Cape San Roque, seem to consider that the group may have been connected at one time with the mainland at this point. We have not seen the specimens, but from the form and arrangement of the rocks here it may be doubted that the evidence is sufficient to prove a connection, while the presence and position of the scoria-beds of Pedras Pretas seem most clearly to prove that there was here a large and active-enough crater to supply nearly all the basalt upon the island.

Now all volcanic activity has long ceased and the last stage in the geological history of the island, that of its breaking up into smaller islets and its slow destruction by denudation, has been reached.

The Coral Reef.

The reef lying round the group of islands, though of considerable extent, does not entirely surround them, but occurs in irregular patches of varying extent. As much interest has been lately shown in the structure and origin of reefs, a few notes made here may be of some value. The reef, in structure, is a whitish-brown, friable, calcareous rock, which, when broken, shows, except for a short way below the surface, no identifiable animal- or plant-remains. It weathers into caves and hollows and rock-pools, so that there are often caverns excavated deep underneath the ledges, into which, at low water, the sea rushes with great velocity expelling the air violently.

The largest of these blow-holes is at Rat Island, where the rush of spray through the hole attains so great a height that it can be seen for some miles.

Where the reef has been raised above sea-level and subjected to aerial decomposition, it seems to be oolitic in structure and finely granular. In comparing it with the reef-rock of the well-known Recife at Pernambuco, it seems that the latter is harder and more compact.

In ~~the~~ rock-pools and crevices of the reef live an immense abundance of marine animals—corals, sponges, echinoderms,

worms, crustacea, and mollusca being very abundant; and over and round the edges grow many calcareous Algæ and Foraminifera. Although it is natural to talk of it as coral-reef, corals contribute but a small share of its structure. A broken piece of reef shows that layers of *Lithothamnion*, and other calcareous Algæ, with the tubes of *Serpulæ*, *Polytrema rubrum*, and calcareous *débris* form the greater part of the mass. These, however, are only distinguishable at the top of the living reef. About an inch below the surface the remains become indistinguishable.

With respect to the distribution of the reef, it may be noted that it apparently never forms where the cliffs descend directly into the sea, nor on the shores covered with large loose boulders, nor in the sandy bays, but it seems to me that its formation here is to a certain extent dependent on the streams which pour into the sea at different points. Thus, there are streams at almost if not all the living reefs, viz., at Chaloupe Bay, Sponge Bay, and Sambaquichaba.

The Recife, too, at Pernambuco is at the mouth of the river, and at Itamaraca, further along the coast to the north, Mr. Ramage, who visited it, reports very extensive reef; and here, again, rivers enter into the sea.

I imagine that the nullipores, corals, and other plants and animals which make the reef cannot grow upon sand which is always shifting, nor upon irregular boulders; but where the sand becomes mixed a little with silt, or the gravel consolidated by it, they can grow and thrive.

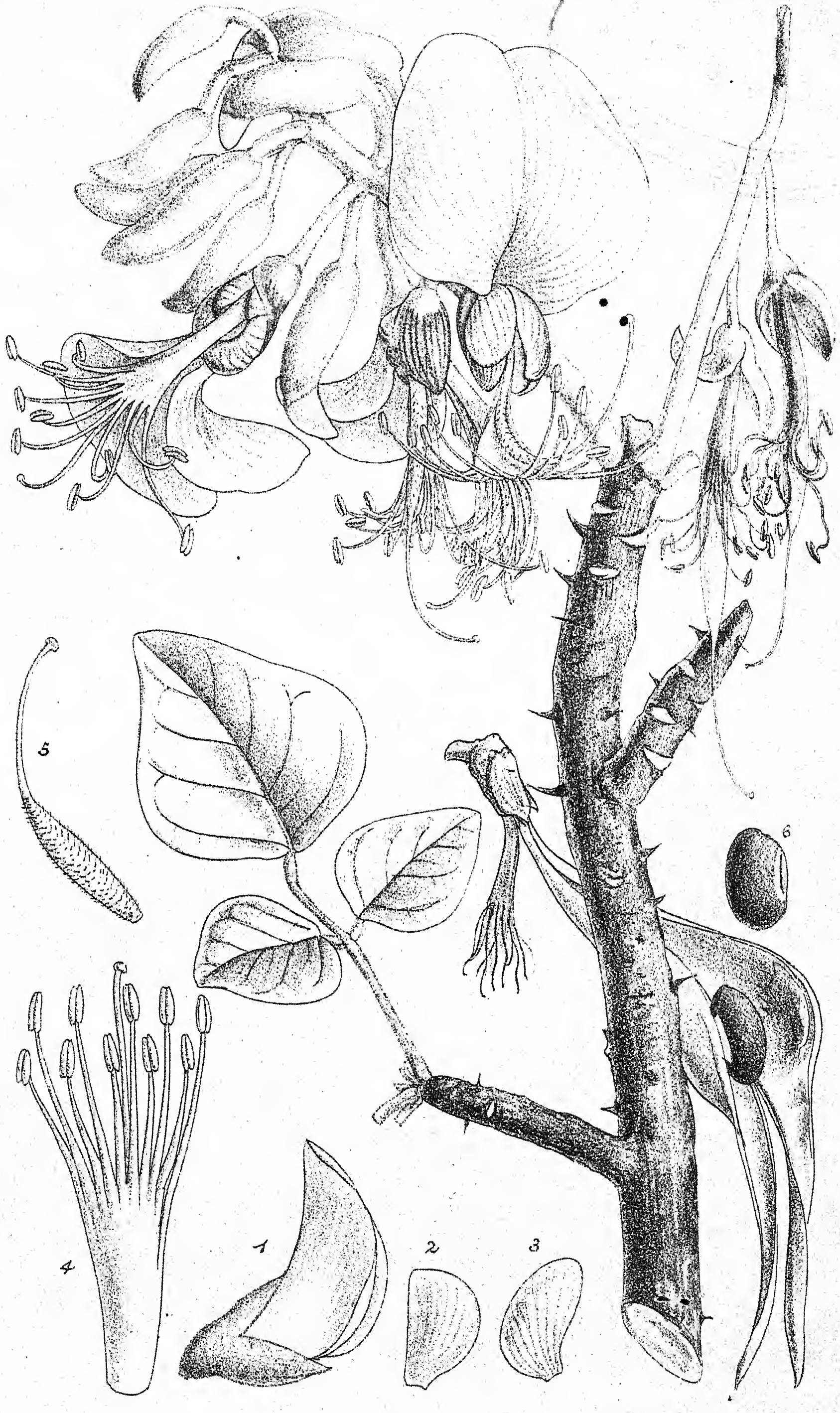
The reef grows only in water just below high-water mark, and abruptly terminates in ledges, beneath which are usually hollows and caverns. The chief growth is along the edges exposed to the waves. Sometimes, as at Sponge Bay, the outer edge of the reef is much higher than the inner portion, probably owing to the more rapid growth here of the nullipores.

The shore of the neighbouring bays consists of sand or basalt pebbles, and there is no more reef till Sambaquichaba, where a narrow spit or two runs out into the sea. We saw no more reef on this side of the island. On the south side, beginning again at the east, there is a very extensive reef in Sponge Bay, of considerable thickness and covered at high water. Beyond the reef, exposed at low water, there seems to be a lower ledge of great extent. Far out at low water can be seen two rocks just raised above high water, over which the sea constantly breaks. These are, I

believe, the rocks marked on the Admiralty Chart as "the Brothers." The name is not known to the inhabitants, who have given the same appellation to the twin rocks off Sambaquichaba. Passing round the coast, we come next to Cotton-tree Bay, where there is a reef some little way from the shore and covered at high water. On the west corner of the bay is a deposit of reef-rock, 100 feet above sea-level and 100 feet in thickness, overlying basalt. No more is met with till Tobacco Point, where is a large deposit of raised reef.

The living reef at the present day occurs on the islands in a number of spots, not continuously, but here and there, sometimes in the form of short spits, at others covering large extents of the sea-bottom. In Rat Island it covers the whole of the western corner and attains considerable thickness in parts; but the only living reef is on the south-west angle, where the sea beats violently from the south. The rest of the corner consists of a deposit of dead reef, with a layer of guano from 4 to 10 metres thick overlying it. In one spot it overlies a beach of basalt-pebbles of large size, which is continuous with a similar uncovered beach to the north. The dead reef projects in the form of weathered pinnacles all over this part of Rat Island and also in Booby Island, which is evidently a continuation of the same reef broken through after being raised above sea-level by the waves. The reef here rings to the hammer, and is very hard and compact; it appears to have much sand in it. Egg Island is apparently also a continuation of this reef.

The island known as San José, or Platform Island, is composed of a basis of basalt, still connected with the mainland by a band of basalt, forming a kind of ridge of pebbles, bare at very low tides. It appears to be the remains of a large promontory, of which the Morro do Chapeo forms a part. It is a basalt rock about 90 feet high, is capped with reef about 6 feet thick, and containing more distinguishable animal-remains than most of the raised reef. The reef on Morro do Chapeo is about the same height above sea-level (about 10 feet) as that on Egg Island, and very much lower than that on San José. Passing along the north side of the Main Island, there is no reef till we reach Chaloupe Bay, the shore consisting of large basalt pebbles, with very large crystals of olivine and enstatite at the extreme eastern point, and sand from San Antonio Bay to Chaloupe Bay. In Chaloupe Bay there is a large patch of living coral-reef, extending the whole length of the bay, and entirely covered at high water.



J. N. Fitch lith.

Fitch imp.

ERYTHRINA AURANTIACA, *Ridl.*

J. N. Fitch del. et lith.
Fitch. imp.

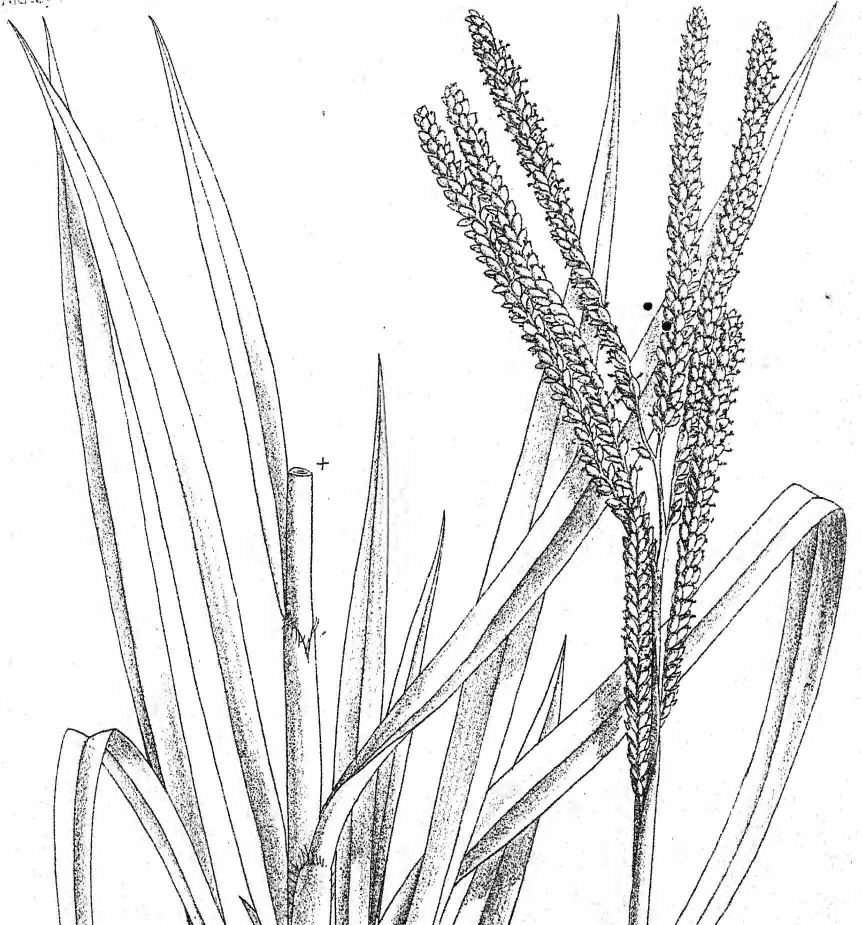
1, 2. CYPERUS CIRCINATUS, *Ridl.* 3, 4. OXALIS SYLVICOLA, *Ridl.*

Ridley.

J.N. Fitch lith.

SAPIUM SCELERATUM, *Ridl.*

Fitch imp.



J.N.Fitch del.et lith.

PASPALUM PHONOLITICUM, *Ridl.*

Fitch imp.

EXPLANATION OF THE PLATES.

Plate I.

Erythrina aurantiaca, Ridl.

Fig. 1. Half-expanded flower, side view. Figs. 2, 3. Alæ. Fig. 4. Andrœcium and pistil. Fig. 5. Pistil. Fig. 6. Seed.
(Figs. 3–5 magnified.)

Plate II.

Cyperus circinatus, Ridl.

Fig. 1. Entire plant. Fig. 2. Flower, magnified.

Oxalis sylvicola, Ridl.

Fig. 3. Entire plant. Fig. 4. Stamens and pistil, magnified.

Plate III.

Sapium scleratum, Ridl.

Fig. 1. Flower-buds. Fig. 2. Inflorescence. Figs. 3 and 4. ♂ flowers. Fig. 5. Stamen. Figs. 6 and 7. ♀ flowers.
(All the details enlarged.)

Plate IV.

Paspalum phonoliticum, Ridl.

Fig. 1. Diagram of flower. Figs. 2 and 3. Flowers, the details enlarged.

A Monograph of the *Thelephoreæ* *.—Part II. By George Massee. (Communicated by W. T. Thiselton Dyer, C.M.G., F.R.S., F.L.S.)

[Read 2nd May, 1889.]

(Plates V.–VII.)

Hymenochæte, *Lév.*

Receptaculum (pileus) coriaceum, membranaceum, forma varium. Hymenium setulis rigidis minutissimis persistentibus obsitum. Basidia tetraspora. Sporæ albæ vel olivaceæ.—*Lév. in Ann. Sci. Nat.* sér. 3, v. p. 150; *Cooke, Grevillea*, viii. p. 145.—Thelephora, Stereum, Corticium, *Auct. pro parte.*

A well-marked genus, characterized by having the hymenium studded with smooth, acute, thick-walled, coloured setæ, which

* Continued from Linn. Journ. Soc., Bot. vol. xxv. p. 155.

are undoubtedly modified cystidia. A few aberrant species with thin-walled, pale-coloured setæ more or less studded with lumps of lime connect the present genus with *Peniophora*.

I. *Stipitatæ.*

HYMENOCHÆTE RENIFORMIS, *Lév.* (Plate V. fig. 1.) Coriaceum, cinnamomeum; pileo dimidiato reniformi integerrimo zonato, stipite e basi toruloso decumbente adscendente; hymenio lævi, velutino; setis conico-cylindraceis, 60–90×12–14 μ; sporæ ellipsoideæ, 4×2–3 μ.—*Lév. in Ann. Sci. Nat.* sér. 3, v. p. 151; *Cooke, Grev.* viii. p. 145.—Stereum reniforme, *Fr. Epicr.* p. 546; *Fr. Nov. Symb.* p. 93; *Berk. in Hook. Kew Journ.* viii. 1856, p. 273.

On the ground, probably springing from buried branches. Brazil.

Closely resembling in general appearance *Hymenochæte damæcornis*, but distinguished by the entire margin of the pileus and also by the much smaller spores and setæ, the plant is also frequently altogether larger; pileus 1–3½ in. broad; stem 2–4 in. long.

HYMENOCHÆTE DAMÆCORNIS, *Lév.* Coriaceum, intus helvolo-filamentosum; pileis pluribus dilatatis planis, rugosis, glabris, verticillatim et lateraliter adnatis; stipite centrali simplici, velutino fusco-atro; hymenio lævi, setuloso, badio; setulis 80–120×8–10 μ; sporæ 7×3–4 μ.—*Lév. in Ann. Sci. Nat.* sér. 3, v. p. 151; *Cooke, Grev.* viii. p. 145.—Stereum damæcorne, *Link, Diss.* i.; *Fr. Epicr.* p. 546. Thelephora damæcorne, *Fr. in Linnæa*, v. p. 524.—*Exs.*: Fung. Cub. Wrightiani, 414.

On stumps and branches. Cuba; Venezuela; Bahia; St. Domingo.

Pilei often flabelliform or spathulate, margin more or less incised 1–2 in. across; stem from 2–5 in. long, 2–3 lines thick, several often originating from a common base.

HYMENOCHÆTE FORMOSA, *Lév.* *H.* pileis pluribus coriaceis, planis, dilatatis, nudis, fulvo-ferrugineis, zonis badiis variegatis, basi attenuatis, stipiteque setuloso sublignoso concolore adnatis; margine tenui, fimbriato, subtus sterili, badio; hymenio pileo concolore, setulis fuscis.—*Lév. Champ. Mus.* p. 151.

Guadaloupe.

HYMENOCHÆTE SPECIOSA, *Lév.* Subcoriacea, ferruginea, undique velutina; pileo ad stipitem torulosum in lacinias plures, erectas, fimbriatas diviso; hymenio infero subsulcato, setuloso.—*Lév. Ann. Sci. Nat.* sér. 3, v. p. 151.—Thelephora speciosa, *Fries, in Linnæa*, v. p. 525; *Epicr.* p. 536.

United States.

II. *Apodes. Sporæ albæ, setulæ acuminatæ.*

HYMENOCHÆTE RUBIGINOSA, *Lév.* Coriaceo-rigida; pileo effuso, reflexo, subfasciato, velutino, rubiginoso, dein glabrescente, spadiceo, strato intermedio fulvo-ferrugineo; hymenio ferrugineo; setulis conico-acutis vel cylindraceo-obtusiusculis, 80–100 $\times$ 5–8 μ; sporæ ellipsoideæ, 5 $\times$ 3 μ.—*Lév. in Ann. Sci. Nat.* sér. 3, v. p. 151; *Grev.* viii. p. 145.—Stereum rubiginosum, *Fr. Epicr.* p. 550; *Fr. Hym. Eur.* p. 641; *Berk. Outl.* p. 271. Thelephora rubiginosa, *Schrader, Spic.* p. 185; *Fr. Syst. Myc.* i. p. 436; *Fl. Dan.* t. 1619. (Specimen from Persoon, in Herb. Kew.)—*Exs.*: Sacc. Myc. Ven. 33; Desm. Pl. Crypt. Fr. 1289; Fuckel, Fung. Rhen. 1319; Ellis, North-Amer. Fung. 329; Roum. Fung. Sel. Gall. 106; Moug. et Nest. St. Crypt. 394; Kunze, Fung. Sel. 203; P. Karsten, Fung. Fenn. 915; Roum. Lichenes Gall. 838; Fung. Brit. Cooke, 415; Desm. Crypt. Fr. ser. i. 415; Berk. Brit. Fung. 247.

On hard wood. Britain; Europe; N. America; Cuba; Patagonia; Mexico; S. Africa; Australia; Tasmania; Nilghiris; Borneo; Bonin Is.

Sometimes altogether adnate or with the margin only free, or with little reflexed pileoli springing as it were from the surface of the adnate portion, or broadly reflexed and densely imbricate, ferruginous brown, with often a purple tinge; margin usually brighter and becoming smooth. Hymenium sometimes concentrically undulate. In addition to the normal setæ, stout cylindrical, obtuse, thin-walled, pale brown bodies, intermediate between setæ and cystidia, are sparingly met with in the hymenium. Somewhat resembling *H. tabacina*, but distinguished at once by the colourless spores.

HYMENOCHÆTE PALLIDA, *Cooke & Massee*, n. sp. Cartilagineo-coriacea; pileo reniformi v. subflabellato, applanato, spongioso-velutino, pallido, concentrice sulcato-zonato, margine sublobato,

acuto; hymenio lineato-rugoso, velutino, umbrino, subrutilante; setis prominulis, subclavatis, 40–50×5 μ; sporæ ellipsoideæ, 6×3–4 μ. (Type in Herb. Kew.)

Mexico.

Pilei thin, 1–2 in. across, densely velvety, the pile arranged in a porous sponge-like manner, pallid, when old almost white.

HYMENOCHÆTE ATTENUATA, *Lév.* *H.* pileis imbricatis, coriaceis, reflexis, strigoso-hirsutis, spadiceis basi attenuato-cucullatis, zonis confertis obscurioribus; hymenio tabacino, setuloso, setulis 90–100×10 μ; sporæ ellipsoideæ, 5–6×3–4 μ.—*Lév. in Ann. Sci. Nat.* sér. 3, v. 1846, p. 152; *Cooke, Grev.* viii. p. 146.—Stereum attenuatum, *Lév. in Ann. Sci. Nat.* sér. 3, i. p. 212. (Specimen from Léveillé in Herb. Berk. n. 3696.)

On trunks. Java.

Adnate, with the margin free or reflexed, concentrically ridged; margin flexuous, strigose. Closely related to *H. tabacina*, but distinguished by the imbricated pilei being attenuated at the base.

HYMENOCHÆTE RHEICOLOR, *Lév.* Dimidiato-cæspitosa, sessilis aut effuso-reflexa; pileis imbricatis semiorbicularibus, tenuissime papyrinis, supra velutinis, concentrice zonatis, zonis concoloribus, primo rhabarbarinis, tandem fuscescentibus; hymenio substriatulo, cinnamomeo, setuloso; setulis cylindraceo-acuminatis, 80–100×6–8 μ; sporæ ellipsoideæ, 6–7×4 μ.—*Lév. in Ann. Sci. Nat.* sér. 3, v. p. 151.—Stereum rheicolor, *Mont. in Ann. Sci. Nat.* sér. 2, xviii. p. 23. (Authentic specimen from Montagne in Herb. Berk.)

On wood. Nilghiris, India.

Pilei 1–2 in. across, very thin; closely resembling in general appearance *Sterum pulchrum* and *Hymenochæte læte*; for distinctive features, see under these species.

HYMENOCHÆTE PHŒA, *Berk.* *H.* pileo dimidiato, sessili, tenui, coriaceo-flexili, zonato, breviter hirto, subvelutino, badio; hymenio æque ac pileo sulcato, setuloso, ferrugineo; setis sparsis, conico-acuminatis, 30–50×6–7 μ; sporæ subglobosæ, 4×3 μ.—*Cooke, Grev.* viii. p. 146.—Stereum phœum, *Berk. in Hook. Fl. N. Zealand,* ii. p. 183. (Type in Herb. Berk. n. 3707.)

On bark and wood. New Zealand; Tasmania.

Laterally attached, imbricated, 3–4 inches long, concentrically

zoned, blackish umber when dry; strigose, with alternating dark and pale zones, margin crisped; hymenium umber.

Hymenochæte rigidula, *Berk. & Curt.* Effuso-reflexa, rigidula, sursum zonata, velutina, spadicea; hymenio vinoso-ferrugineo inæquabili; setulis acutis, 30–40 × 8 μ; sporæ ellipsoideæ, 3 × 2 μ.—*Berk. & Curt. Journ. Linn. Soc.* (*Bot.*) x. p. 334. (Type in Herb. Berk. n. 3704.)

On dead wood. Cuba; Ceylon.

Rigid, thickish; often broadly effused, margin generally free and more or less lobed, yellow or amber in young plants; hymenium chocolate, with rust tinge.

Hymenochæte læta, *Berk.* *H.* pileis imbricatis, reniformibus tenuissime papyrinis, velutinis, concentrice zonatis, primo læte ferrugineis demum fuscescentibus; hymenio cinnamomeo, velutino; setulis paucis, tenerrimis, 20–30 × 4 μ; sporæ subglobosæ, 4 × 3 μ.—Stereum lætum, *Berk. & Curt. Journ. Acad. Nat. Sci.* (April 1853), p. 279 (pro parte).

On wood. British Guiana.

Pilei imbricated, 1–2 in. long, about 1 in. across from the base, thin, when young bright orange-rust, then becoming dingy.

This species is not "*Thelephora læta* in Herb. Mont." as stated by Berkeley in Grev. viii.; but there is a specimen from Montagne, marked "*Thelephora* (*Stereum*) *rheicolor*, Montag.," on the same sheet with the above, and with which Berkeley appears to have confounded it, as also with *Stereum pulchrum*, Schw.

Hymenochæte elegantissima, *Massee.* *H.* pileis gregariis, horizontaliter seriatis, sæpius lateraliter confluentibus, necnon superposito-imbricatis, subconchatis, dimidiato-expansis, parvulis 2 centim. diam., 1–1·5 centim. lat., aut post. cuneatis v. truncato-adnatis, non v. parce subcrenato-repando, tenuiusculi membranaceis, flaccidis sed tenacellis, superne dense concentrice sulcato-striatis, e gilvo-castaneis, sulcis obscurioribus glabris sed adpressime sericeo-fibrosis, modice nitentibus; hymenio plano v. concavo, concentrice undulato e fulvo v. subcorneo-umbrino, sulcis subobscurioribus; margine subpallidiore, dense minutissimeque setuloso, setulis e conico-teretibus, continuis, 50–70 × 10–15, ochraceis levibus.—*Spegazzini, Fung. Guar.* Pug. i. n. 74.

On wood. Paraguay.

Related to *Hymenochæte tabacina.*

HYMENOCHÆTE KUNZEII, *Massee.* *H.* pileo dimidiato, sessili, ceriaceo-membranaceo, tenui, rigido, fragili, fusco, sericeo-velutino marginato, zonis minutis concoloribus; hymenio subtiliter velutino, ferrugineo; setulis tenuibus, cylindraceo-acuminatis, 40–50 $\times$ 10–12 μ; sporæ ellipsoideæ, 10 $\times$ 5 μ.—Hymenochæte Kunzeii, *Hook. Bot. Miscell.* ii. p. 163, t. lxxxv. Thelephora badia, *Kunze, in Weig. Exs. Turin* (not of *Hooker*).—*Exs.*: Spruce, Lichenes Amazonici et Andini, 797. (Specimen from Kunze in Herb. Kew.)

Surinam; Bahia; Amazon valley.

About 2 inches long, 2–3 inches broad; pileus ferruginous, shining, velvety, slightly zoned; hymenium ochraceous, covered with ferruginous setæ.

HYMENOCHÆTE CACAO, *Berk.* Tabacina, pileis imbricatis connato-flabelliformibus, plicatis zonatis strigosis; hymenio concolore subtiliter setuloso, setulis cylindraceo-acuminatis, 30–40 $\times$ 5–6 μ; sporæ ellipsoideæ, 7 $\times$ 4 μ.—*Berk. in Trans. Linn. Soc.* ser. 2, (*Bot.*) i. p. 403, pl. xlvi. figs. 1–3.—Stereum Cacao, *Berk. in Hook. Kew Journ. Bot.* vi. p. 169. (Type in Herb. Berk. n. 3697.)

On dead timber. Khasia Mts. (*Dr. Hooker*).

Forming dense orbicular patches, 3 inches or more in diameter, closely imbricated; pilei thin but rather rigid, flabelliform, connate, deeply lobed and plicate, furrowed with a few zones, of a rich chocolate-brown, velvety; hymenium marked with a few concentric ridges, of the same colour as the pileus, minutely setulose. A very pretty species, allied to *S. rubiginosum*, but far more minutely setulose than its allies (*Berk.*).

Thin, strigose, becoming smooth, rugulose from base to margin, and concentrically zoned, chocolate colour all over; densely imbricated.

HYMENOCHÆTE ASPERA, *Berk. & Curt.* Rubiginosa; pileo dimidiato imbricato zonato innato-fibroso, fibris fasciculatis postice reticulatis; hymenio colliculoso aspero; setulis tenuibus acuminatis, 40–50 $\times$ 5–6 μ; sporæ ellipsoideæ, 4 $\times$ 2 μ.—*Berk. & Curt. in Journ. Linn. Soc.* x. p. 334. (Type in Herb. Berk. n. 3703.)

On rotten wood. Venezuela; Cuba.

Large, imbricated, 3–4 inches across; spongy and pliant when dry, thickly covered with bright yellow, long, pliant spines, margin fimbriate; hymenium irregularly tuberculose, dark ferruginous brown, often with yellow spines bursting through from the pileus.

HYMENOCHÆTE BERKELEYANA, *Cooke*. *H.* pileis membranaceo-papyrinis, cæspitoso-imbricatis, dimidiatis, lobatis, margineque proliferis, e spadiceo fuligineis, lentis, appresse puberulis; hymenio concolore, setuloso; setulis 40–60 × 7–10 μ; sporæ ellipsoideæ, 7 × 3 μ.—*Cooke, Grevillea*, viii. p. 147. Stereum Berkeleyanum, *Mont. Guy.* n. 413; *Mont. Syll. Crypt.* n. 589. (Specimen from Montagne in Herb. Berk.)

On bark. Cayenne.

Thin, umber, attached by a narrow base.

HYMENOCHÆTE SUBPURPURASCENS, *Massee*. Rigidula, coriacea, sulcato-zonata, ferruginea, tomentosa; contextu rufo; hymenio atro-purpureo, minutissime velutino; setulis conicis, 43 × 60 × 5–7 μ; sporæ ellipsoideæ, 8–10 × 4–5 μ.—Stereum subpurpurascens, *Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 66. (Type in Herb. Berk. n. 3777.)

On dead wood. Ceylon; Goping, Malay peninsula.

About 6 inches wide, 2½ long, of a rigid, coriaceous substance, repeatedly zoned and sulcate, variegated with brown and umber; the ridges tomentose, with little radiating prominences; hymenium with a velvety aspect, from very minute brown bristles. (*Berk. & Broome.*)

Margin sometimes deeply lobed and undulating, strigose, becoming almost smooth.

HYMENOCHÆTE BADIO-FERRUGINEA, *Lév.* *H.* pileis papyraceis, umbonato-sessilibus imbricatis, conchiformibus, supra sericeis lineato-radiatis ob zonas concentricas badias et ferrugineas alternantes variegatis, subtus contextuque sordide luteis; hymenio setuloso; setulis conico-acuminatis, 50–80 × 7–8 μ; sporæ ellipsoideæ, 7 × 4 μ.—*Lév. in Ann. Sci. Nat.* sér. 3, v. p. 152; *Cooke, Grev.* viii. p. 146.—Stereum badio-ferrugineum, *Mont. Cent.* iv. n. 87; *Mont. Syll. Crypt.* n. 586. (Specimen from Montagne in Herb. Berk. n. 3700).—*Exs.*: Rav. Fung. Amer. 718.

On wood and bark. United States.

Small; ¼–½ inch across, attached by the centre, the margin free, or sometimes laterally attached. Hymenium often minutely cracked in a radiating manner, as in *H. tabacina*.

HYMENOCHÆTE SALLEI, *Berk. & Curt.* *H.* pileo papyraceo, ferrugineo, repetite zonato, pilis decumbentibus sericeo-velutino plicato; margine lobato; hymenio spadiceo antice crocato; setulis

70–120 × 10–12 μ; sporæ subglobosæ, 8 vel 7 × 8 μ.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 333; *in Grev.* viii. p. 147. (Type in Herb. Berk. Kew. n. 3699.)

On wood. Cuba; Cordova.

Broad, circular, and fixed by the centre or laterally, 3–4 inches across, very thin and flexible, like paper when dry; concentrically zoned, silky-strigose; hymenium ferruginous-brown; margin often paler and brighter.

Hymenochæte strigosa, *Berk. & Broome.* Dimidiata, postice decurrens, tenuis, eximie lobata zonata spadicea, purpurea tingente, strigosa; hymenio umbrino; setulis acuminatis, 30–40 × 6–8 μ; sporæ ellipsoideæ, 5 × 3 μ.—*Berk. & Broome in Journ. Linn. Soc.* xiv. p. 68. (Type in Herb. Berk. n. 3702.)

On dead wood. Ceylon.

From 1–3 inches across; margin lobed, concentrically sulcate, coarsely strigose, dark brown with purple tinge; hymenium chocolate.

Hymenochæte spadicea, *Berk. & Broome.* *H.* pileo tenui, sicco elastico, dimidiato vel suborbiculari, postice affixo, zonato, strigoso, e ferrugineo spadiceo; hymenio velutino, lineato rugoso, pallide umbrino; setulis acuminatis, 30–40 × 5–6 μ; sporæ oblongo-ellipsoideæ, 5 × 2 μ.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 68. (Type in Herb. Berk. n. 3706.)

On dead wood. Ceylon; Australia.

Thin, pliant even when dry, growing horizontally from a central point, several often confluent; hymenium greyish umber.

Hymenochæte tenuissima, *Berk.* *H.* pileo umbonato, sessili tenuissimo dilatato, fulvo-rubiginoso zonato fasciculato-villoso; hymenio inæquabili luteo-rubiginoso; setulis acuminatis, 40–60 × 10 μ; sporæ ellipsoideæ, 5–6 × 3 μ.—*Berk. in Journ. Linn. Soc.* xiv. p. 67.—Stereum tenuissimum, *Berk.*, *in Hook. Lond. Journ. Bot.* vi. 1847, p. 510; *Husnot, Pl. des Antill.* 595; *Fung. Cub. Wrightiani*, 418. (Type in Herb. Berk. n. 3694.)

On wood. Adam's Peak, Ceylon; Cuba; Mexico; Brazil; Himalayas; Queensland.

Pileus at first umbonato-sessile, laterally confluent, dilated, 1 inch or more long, extremely thin and flexible, so that it may be folded in any direction without breaking; tawny, rubiginous,

repeatedly zoned, clothed with coarse pubescence, which is collected into little fascicles. Hymenium unequal, rather yellower than the pileus. Nearly allied to *Thelephora attenuata*, Lév., *Stereum luteo-badium*, Kze., and some other similar forms, but distinct from all in its very flexible pileus, coarser pubescence, and redder tint. (*M. J. Berkeley.*)

HYMENOCHÆTE AVELLANA, *Cooke*. Coriacea, dura; pileo effuso margineque obtuso, libero, anguste reflexo, spadiceo villoso; hymenio lævi e velutino pruinato glabratoque ferrugineo-pallente (passim cruentato); setulis cylindraceis, obtusiusculis, 80–140 × 7–9 μ; sporæ cylindraceo-ellipsoideæ, 6–7 × 3 μ.—*Cooke, Grev.* viii. p. 146.—Stereum avellanum, *Fr. Epicr.* 551; *Hym. Eur.* 462. Thelephora juratensis, *Pers. Myc. Eur.* p. 125. (Specimen from Fries in Herb. Berk. n. 3692.)

On hazel, beech, &c. Britain; Europe; New England.

Patches small as a rule, sometimes effused; margin free all round or reflexed above; hymenium when dry dingy ferruginous, pruinose.

HYMENOCHÆTE FERRUGINEA, *Massee*. Coriaceo-rigida, tenuis, tenax, fusco-ferruginea; pileo effuso reflexoque, dense concentrice sulcato, e leproso-villoso glabrato; hymenio nudo, levi, subtilissime velutino; setulis sparsis, acuminato-conicis, 40–60 × 6–8 μ; sporæ ellipsoideæ, 6 × 3–4 μ.—Auricularia ferruginea, *Bull. Champ.* t. 378. Stereum ferrugineum, *Fr. Epicr.* 550; *Hym. Eur.* 640. (Specimen from Fries in Herb. Berk. n. 3805.)

On old pine and other wood. Europe; Brazil; Ceylon; New Zealand.

Often densely imbricated, thin, flexible; hymenium when dry ochraceo-cinnamon, inner texture same colour. Superficially resembling *H. rubiginosa*, from which it differs in the larger spores and hymenium appearing almost smooth under a lens.

HYMENOCHÆTE IMBRICATULA, *Lév.* Resupinato-effusa, interdum in pileolos crebros imbricatos porrecta; margine subiculoque sordide luteis, spongioso-tomentosis; hymenio umbrino; setis conico-acutis vel subclavatis, interdum asperulis, 30–60 × 8–10 μ; sporæ ellipsoideæ, 7 × 5 μ.—*Lév. in Ann. Sci. Nat.* sér. 3, v. p. 152; *Cooke, Grev.* viii. p. 146.—Thelephora (Stereum) imbricatula, *Schw. Syn. N.-Amer. Fung.* n. 637. (Specimen from Schweinitz

in Herb. Berk.) Stereum umbrinum, *Berk. & Curt. N.-Amer. Fung., in Grev.* i. p. 164, n. 240. (Type in Herb. Berk. Kew. n. 3710.)—*Exs.*: Rav. Fung. Amer. 445.

On wood. Lower Carolina.

Broadly effused and altogether adnate, or with numerous pileoli springing from the adnate portion, often in an imbricated manner; frequently the pileoli or reflexed portions are exceedingly narrow. Thin and soft. In some specimens the pileus is very finely rimose, and the patches appear as if composed of numerous confluent individuals.

HYMENOCHÆTE FULVELLA, *Berk. & Curt.* Effusa, subcoriacea, læte ferruginea, margine lobato, interdum libero, subtus obscuriore; hymenio velutino, hinc inde scruposo vel rimuloso; setis conico-acutis, 70–90 × 10–18 μ; sporæ ellipsoideæ, 8 × 4 μ.—*Berk. & Curt. in Grev.* viii. p. 148. (Type in Herb. Berk. n. 3721.)

Ferruginous, adnate, broadly effused, often wrinkled or cracked in patches on the hymenium.

HYMENOCHÆTE PULCHERRIMA, *Massee*, n. sp. (Pl. V. f. 4.) Late effusa, adnata, margine determinato, subreflexo, subtus croceo-fuscescens, strigosa; hymenio colliculoso aspero, velutino, cervino; setis conico-acuminatis, 70–90 × 18–22 μ; sporæ ellipsoideæ, 4 × 3 μ. (Type in Herb. Berk. Kew. n. 3721 *a*.)

On bark. Venezuela.

Broadly effused, thin, adnate; margin free and sometimes partly upturned, strigose and bright yellowish brown below. Remarkable for the very thick conico-acuminate setæ.

HYMENOCHÆTE PERPUSILLA, *Pat.* Parva, 4–8 millim. lata, orbicularis, coriacea, patulo-reflexa, brunneo-rubra; margine acuto, lævi, integro; hymenio ochraceo-ferrugineo, lævi, setuloso; setulis brunneis, brevibus, ad marginem carentibus.—*Patouillard, Champ. Nouv. Caledon.* p. 5.

On dead wood. New Caledonia.

III. *Resupinatæ.* † *Sporæ albæ, setæ acuminatæ.*

HYMENOCHÆTE NIGRESCENS, *Cooke, in herb.* (Pl. V. f. 5.) *H.* pileis peltatis, applanatis, solitariis vel gregariis ac confluentibus, rigidis, ambitu liberis subreflexis; hymenio setuloso, e fusco-

nigrescente; setulis conicis nigricantibus, 80–140 × 10–12 μ; sporæ ellipsoideæ, 10 × 5 μ. (Type in Herb. Kew.)

On dry wood. Britain.

Adnate; margin free, sometimes upturned, almost smooth and greyish below. Commencing as circular patches, which usually soon become confluent. Often radially cracked through the entire substance. Hymenium blackish umber, setulose; setæ almost black and opaque, numerous.

Hymenochæte crocata, *Lév.* Coriacea, firma, ferrugineo-pallens, pileo effuso; margine tenui, undique anguste reflexo, subtus strigoso-tomentoso, intus filamentoso croceo; hymenio pallido, setulis sparsis ferrugineis punctato; setulis cylindraceis, apice acuminatis, 70–100 × 6–8 μ; sporæ ellipsoideo-fusoideæ, 6 × 2–3 μ.—*Lév. in Ann. Sci. Nat.* 1846, p. 151; *Grev.* viii. p. 145.—Stereum crocatum, *Fr. Hym. Eur.* p. 641. Thelephora Cerasi, *Pers. Myc. Eur.* p. 125.—*Exs.*: Rav. Fung. Amer. 123.

On trunks &c. S. Europe; United States; Mexico; Venezuela; Ceylon.

Sometimes entirely adnate, and margin almost indeterminate; in young specimens the margin is often free, upturned, strigose, citron or orange, becoming smoother and duller in colour with age.

Hymenochæte dura, *Berk. & Curt.* Resupinata, orbicularis, crassa, rigida, ferrugineo-rhabarbarina, margine obtuso; hymenio lævi; setulis acuminatis, 30–35 × 6–7 μ; sporæ ellipsoideæ, 5 × 3 μ.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 334.—*Exs.*: Fung. Cub. Wrightiani, 422. (Type in Herb. Berk. n. 3719.)

On wood and bark. Cuba; Jamaica; Ceylon.

Consisting of thick, small, irregular patches, with the pale margin abrupt and free; hymenium cinnamon, tinged ferruginous; setæ rare, sometimes almost entirely absent.

Hymenochæte tasmanica, *Massee*, n. sp. (Pl. V. f. 2.) Latissime effusa, crustaceo-adnata, crassiuscula; margine tenuiore pallidiore, demum leviter libero; hymenio rugoso-tuberculoso, velutino, ferruginoso, margine pallidiore; setulis longissimis, subcylindraceis vel basi inflatis, 100–200 × 8–10 μ; sporæ subcylindraceæ utrinque obtusissimæ, 7 × 3 μ. (Type in Herb. Berk. Kew. along with *H. rubiginosa.*)

On wood. New Zealand.

Broadly effused, adnate; extreme margin free, sometimes slightly curled; substance rigid when dry; hymenium rugose or tuberculose, velvety, bright ferruginous, margin sometimes almost orange. Closely resembling in general appearance *Hymenochæte rubiginosa*, but readily distinguished by the very long setæ and narrowly cylindrical elongated spores.

HYMENOCHÆTE STEVENSONI, *Berk. & Broome.* Pallide cervina, rigida, margine obtuso elevato; setis rigidis, 20–40 × 8–10 μ; sporæ elliptico-fusoideæ, 6–7 × 3–4 μ.—*Berk. & Broome in Ann. Mag. Nat. Hist.* ser. 5, iii. 1879, p. 211. (Type in Herb. Berk. Kew. n. 3733.)

On yew. Glamis, N. B.

A very distinct species, with an abrupt margin, which is sometimes a little thickened or raised. Hymenium livid, or greyish with tinge of lilac when dry.

HYMENOCHÆTE PELLICULA, *Berk. & Broome.* (Pl. V. f. 3.) Resupinata, effusa, tenuissima, a matrice hic illic secernibilis, rubiginoso-grisea; margine vix nullo vel tenerrimo; setulis crassis, acuminatis, 30–35 × 10 μ; sporæ ellipsoideæ, 6 × 4 μ.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 65. (Type in Herb. Berk. n. 3725.)

On bamboo. Ceylon; United States.

Forming an even, very thin, broadly effused stratum, brown, with sometimes a grey or purple tinge; setæ often clear purple by transmitted light.

HYMENOCHÆTE AMBIENS, *Berk. & Curt.* Effusa, circumambiens, tenuis, ochraceo-fusca; hymenio leviter velutino; setis cylindraceo-obtusis, 40–80 × 7–9 μ; sporæ ellipsoideæ, 4–5 × 3 μ.—*Cooke, Grev.* viii. p. 147. (Type in Herb. Berk. n. 3691.)

On bark of branches. New Jersey.

HYMENOCHÆTE AGGLUTINANS, *Ellis.* Arcte adnata, determinata, ambitu subtomentosa; hymenio e flavo-rufescente; setulis cylindraceo-acutis, 60–90 × 7–8 μ; sporæ ellipsoideæ, 7 × 5 μ.—*Ellis in Bull. Torr. Bot.* v. no. 2, p. 46.—*Exs.*: Thuem. Myc. Univ. 309. (Authentic specimen from Ellis in Herb. Kew.)

United States.

A well-marked species, and certainly a genuine *Hymenochæte.* Compact, determinate; margin downy, often completely surrounding twigs or cementing two together by growing continuously round both. Hymenium pale, but often bright yellow, with ferruginous shades due to the setæ.

HYMENOCHÆTE CROCICREAS, *Berk. & Broome.* Crassa, resupinata, intus croceo-lateritia, matricem eodem colore tingens.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 68. (No specimen in Herb. Berk.)

On decayed wood. Ceylon.

HYMENOCHÆTE DEPALLENS, *Berk. & Curt.* Effusa; hymenio velutino, pallido, rimoso, contextu molli, fulvo-cinnamomeo; setulis acuminatis, 40–60 × 8–10 μ; sporæ oblongo-ellipsoideæ, 8–10 × 5 μ.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) xiv. p. 68. (Type in Herb. Berk. n. 3723.)

On branches and wood. Ceylon.

Broadly effused, rather thick; margin often byssoid; hymenium pale, cracked in the dry specimens.

HYMENOCHÆTE INSULARIS, *Berk.* Tota resupinata, rubiginosa, primum orbicularis; margine angusto tomentoso candido; hymenio velutino, rimoso; setulis obtusis, 40–50 × 10 μ; sporæ ellipsoideæ, 6 × 3–4 μ.—*Berk. in Grev.* i. p. 165. (Type in Herb. Berk. n. 3736.)

Carolina, on *Castanea sativa*, Mill.

"At first orbicular, with a narrow white tomentose margin; under surface white; at length laterally confluent, ultimately continuous. As in *Polyporus igniarius*, the mycelium which penetrates below the thin bark is white." (*Berkeley.*)

Thin, closely adnate, ferruginous-brown; hymenium velvety; margin paler, minutely fibrillose.

HYMENOCHÆTE LEONINA, *Berk. & Curt.* Tota resupinata, croceo-ferruginea; margine tomentoso; hymenio inæquabili inseparabili nec rimoso; setulis acuminatis, crassis, 20–30 × 12–15 μ; sporæ subglobosæ, 6 × 5 μ. (Type in Herb. Berk. Kew. n. 3715.)

On dead wood. Cuba; Ceylon; Britain.

Broadly effused, thin, firmly adnate; margin almost indeterminate; setæ rare; threads of subiculum coloured; hymenium variable in colour, often ferruginous-orange with patches of pure yellow.

HYMENOCHÆTE LÆVIGATA, *Massee.* Effusa, tenuis, velutina, olivaceo-fusca, subiculo obsoleto; setulis acuminato-conicis, 60–100 × 5–7 μ; sporæ cylindraceo-ellipsoideæ, 7 × 5 μ.—Thelephora (Stereum) lævigata, *Schweinitz, Syn. Fung. N. Amer.* (Specimen from Schweinitz in Herb. Berk.)

On wood. United States.

Effused, thin; margin generally indeterminate, sometimes whitish and minutely byssoid; hymenium olivaceous with a brown or ferruginous tinge, sometimes cracked in an areolate manner.

HYMENOCHÆTE MULTISPINULOSA, *Peck*. Resupinata, obscure rufescenti-brunnea, ambitu pallidiore; hymenio velutino, areolato-rimoso; setis rectis vel leviter flexuosis, confertis, 50 × 110 μ longis.—*Peck in Coult. Bot. Gaz.* vii. (1882), p. 54.

On rotten wood. Arizona; United States.

HYMENOCHÆTE BONAERRENSIS, *Speg*. Latissime effusa, nunquam reflexa, tenaciter ac subcrustaceo-adnata, tenuis, ob matricis inæqualitatem undulata ac hinc inde scrupulosa, pulchre cinerea, densiuscule ac minute piloso-punctulata; margine subindeterminato, zona tenuissima fibrilloso-subaurantiaca, tomentosulo-aurantia v. gossypino-cinnamomeo-fulvo ornata; setulæ hymenii e strato mycelio fibroso-subcartilagineo cinnamomeo exsurgentes, cylindraceo-conicæ, apice acutiusculo, nudo v. calcareo ruguloso-aspero (60–80 × 12–14), basi non incrassatæ, continuæ v. rarius pauciseptatæ, crassæ tunicatæ, sanguineo-fuligineæ; sporæ ellipticæ, sæpius inæquilaterales, utrinque obtusæ, rotundatæ (6–7 × 2) hyalinæ.—*Spegazzini, Fung. Argentini*, Pug. iv. p. 16.

On rotten willow-trunks. Palermo.

HYMENOCHÆTE UNICOLOR, *Berk. & Curt.* Adnata, resupinata, crassiuscula, rigida, cinnamomea, lævis, æquabilis, rimosa, margine leviter pulvinato; intus e basi badia concolor; setulis gracilibus, acuminatis, 40–50 × 5 μ; sporæ ellipsoideæ, 6 × 4 μ.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 335. (Type in Herb. Berk. n. 3728.)—Hymenochæte spreta, *Peck*, 30*th Rep. New York State Mus.* p. 47.

On dead trees. Cuba.

Thick; broadly effused, becoming abruptly thin and minutely radiato-fibrillose at the margin; hymenium brown, cracked.

HYMENOCHÆTE TOXIA, *Berk. in herb.* Latissime effusa, tenaciter ac subcrustaceo-adnata; margine subindeterminato; hymenio umbrino-brunneo, leviter velutino; setulis cylindraceo-conicis, 40–70 × 5–7 μ; sporæ ellipsoideæ, 7 × 4 μ. (Type in Herb. Berk. n. 3729.)

Samoa. Sent by Mr. T. Powell, who states that it does great injury to the bread-fruit trees.

HYMENOCHÆTE TENUIS, *Peck*. Resupinata, tenuissima, lævis, cæspites plus minus confluentes elongatos, obscure ferrugineos, margine determinato concolores, inseparabiles, rimosos efformans; setulis acutis, 30–60 μ longis.—*Peck*, *40th Report New York Mus.* p. 57.

On decorticated wood of *Thuja occidentalis*. N. America.

HYMENOCHÆTE BARBATA, *Massee*, n. sp. Latissime effusa, adnata, crassa; margine obtusiusculo; hymenio læte ferrugineo, ambitu pallescente; setis conico-acuminatis, $80–140 \times 12–17\ \mu$; sporæ ellipsoideæ, $4 \times 2–2{\cdot}5\ \mu$. (Type in Herb. Berk. Kew. n. 3715.)

On wood. Ceylon.

Broadly effused, thick, margin rather obtuse. Agreeing in many respects with *H. pulcherrima*, but the latter is readily distinguished by the free reflexed margin straight below, and the nodulose hymenium.

HYMENOCHÆTE FULIGINOSA, *Lév.* Effusa, coriacea, compacta, obscure fuliginoso-spadicea; hymenio levi, setulis densis, sæpe sparsis, setulis $30–50 \times 6–8\ \mu$; sporæ subglobosæ, $5 \times 4\ \mu$.—*Lév. in Ann. Sci. Nat.* sér. 3, v. 1846, p. 152; *Grev.* viii. p. 147.—Stereum fuliginosum, *Pers. Myc. Eur.* i. p. 145; *Fr. Hym. Eur.* p. 645.—Thelephora fusco-purpurea, *Pers. Myc. Eur.* p. 143 (young condition).—*Exs.*: Fung. Cub. Wrightiani, 429.

On wood. Britain; Europe; Cuba; Venezuela; Ceylon; Nilghiris; Egypt.

Thin, closely adnate; margin very thin, yellowish rust, often much broken into patches and almost indeterminate; hymenium umber with rust or purple tinge, appearing almost smooth under a lens, sometimes minutely cracked and brighter in colour. The setæ are often clear purple by transmitted light, instead of dark brown, the usual tint.

HYMENOCHÆTE INNATA, *Cooke & Massee*. Resupinata, tenuis, innata, extus cervina, intus lateritia, margine indeterminato; setis parvulis gracilibus, $15–20 \times 2–3\ \mu$; sporæ globosæ, $4\ \mu$ diam.—*Cooke & Massee in Grev.* xv. p. 99. (Type in Herb. Kew.)

On wood. Australia (Daintree River).

Innate, scarcely distinct from the subjacent matrix, which is discoloured by the bright brown mycelium.

HYMENOCHÆTE STELLIGERA, *Speg.* Effusa, late incrustans, vegeta contigua, margine attenuato, submembranacea e carneo- vel cinereo-fuscescens, centro crassiuscula, pruinuloso-velutina rufescens vel ferruginea dense minutissimeque setulosa; setulis fuligineis, rigidulis, continuis, apice plus minusve radiato-ramulosis, ramis 20–30×3, apice acutiusculis.—*Speg. Fung. Fueg.* p. 42, n. 103.

On decorticated beech. Staten Island, Tierra del Fuego.

Remarkable for the more or less stellate apices of the setæ, in this character resembling the species of *Stellatostroma*, but in the latter genus the stellate hyphæ are immersed in the substance of the stroma.

†† *Sporæ olivaceæ.*

HYMENOCHÆTE CORRUGATA, *Lév.* Subeffusa, arcte adnata, mox grumosa, pallide cinnamomea; hymenio setis ferrugineis obsito, sicco rimosissimo; setis conico-acuminatis, 70–120 μ; sporæ ellipsoideæ, olivaceæ, 7–8 × 4–5 μ.—*Lév. in Ann. Sci. Nat.* sér. 3, v. p. 152.—Corticium corrugatum, *Fr. Epicr.* 565; *Hym. Europ.* 656. Thelephora corrugata, *Fr. Obs.* i. 154; *Fr. Elench.* 224. Thelephora Padi, *Pers. Myc. Eur.* i. p. 134; *Grevillea*, t. 234. (Specimen from Fries in Herb. Kew.)—*Exs.*: Berk. Brit. Fung. 249 & 298; Thum. Myc. Univ. 9; Rav. Fung. Can. 26; Rav. Fung. Amer. 124; Ellis, N. Am. Fung. 14?

Britain; Europe; N. America.

Broadly effused, closely adnate, so that the irregularities of the matrix are followed by the hymenium, which varies from dark brown, through ferruginous, to dirty grey when dry. There is no shade of purple in the hymenium, which is very much cracked into polygonal areas when dry.

HYMENOCHÆTE CROCEO-FERRUGINEA, *Massee*, n. sp. (Pl. V. f. 9.) Effusa, late incrustans, tenuissima, e croceo-ferruginea fuscescens; hymenio minutissime setuloso, rimoso; setulis cylindraceis, basi inflatis, 70–100×30–35 μ; sporæ subglobosæ, olivaceæ, 7×6 μ.

On dead stem of *Rosa canina*. Britain (Appin, Norths.). (Type in Herb. Berk. n. 3735 *a*.)

Broadly effused, very thin, adglutinated, margin sometimes byssoid, at others indeterminate. Resembling *H. corrugata*, but differing in the very much swollen bases of the setæ and the subglobose spores.

HYMENOCHÆTE TRISTIUSCULA, *Massee.* Late effusa, arcte adnata, tenuis, hymenio obscure fuligineo, ambitu nigro; setulis tenuibus, 40–50 μ; sporæ olivaceæ, ellipsoideæ, $10 \times 4\,\mu$.—Corticium tristiusculum, *Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 71. (Type in Herb. Berk. n. 4045.)

On dead twigs. Ceylon.

Broadly effused, hymenium smoky brown, sometimes with a glaucous tinge, often cracked into minute areolæ. With the habit and general appearance of *Peniophora cinerea.* The hymenium is described by Berkeley as "lævissimo," nevertheless, except when old, it is furnished with setæ, and is a true *Hymenochæte.*

HYMENOCHÆTE CORTICOLOR, *Berk. & Rav.* Irregularis, dura, lignea, coffeicolor demum hic illic liberata; setulis acuminatis, $50–70 \times 10–12\,\mu$; sporæ ellipsoideæ, olivaceæ, $7 \times 3\,\mu$.—*Berk. & Rav. in Grev.* i. p. 165. (Type in Herb. Berk. n. 3714.)

Carolina, Florida. "On the rough bark of old elms. Forming irregular patches of a coffee-brown, hard, woody, either entirely resupinate or with the edge here and there slightly raised. Closely allied to *H. dura*, Berk. & Curt., a Cuban species of a far brighter tint." (*Berkeley.*)

Thick, adnate, hard, following the undulations of the bark; determinate; thin-walled, pale-coloured, cystidia-like bodies accompany the typical setæ. Spores pale olive.

HYMENOCHÆTE EPISPHÆRIA, *Massee.* Effusa, tenuissima, indeterminata; hymenio cinnamomeo, subvelutino; setulis sparsis, cylindraceis, $80–90 \times 8–10\,\mu$; sporæ ellipsoideæ, olivaceæ, $7 \times 4\,\mu$.—Thelephora (Stereum) episphæria, *Schwein. Syn. N. Amer. Fung.*; *Fries, Elench.* 225. (Specimen from Schweinitz in Herb. Berk.)

On bark, running over a *Sphæria.* U. States.

Effused, thin; margin indeterminate; hymenium cinnamon, becoming tinged with olive; pulverulent under a lens; setæ scattered, cylindrical, apex obtuse.

HYMENOCHÆTE MOUGEOTII, *Massee.* (Pl. V. f. 6.) Late effusa, arida, determinata, adnata, obscure sanguineo-rubra; hymenio incrustando inæquali, siccitate rimuloso, pruinato; setulis sparsis, conicis, $30–60 \times 5–6\,\mu$; sporæ fusoideo-ellip-

soideæ, olivaceæ, 6–7×3·5 μ.—Corticium Mougeotii, *Fr. Epicr.* p. 558; *Fr. Hym. Eur.* 654. Thelephora Mougeotii, *Fr. Elench.* p. 188.—*Exs.*: Roum. Fung. Sel. Gal. n. 5; Moug. & Nest. n. 581 (as *Thelephora cruenta*).

On *Pinus picea* and other trunks. Central Europe; Tasmania; Sikkim Himalayas, 1100–1200 feet.

HYMENOCHÆTE TABACINA, *Lév.* Subcoriacea, tenuis, flaccida, pileo effuso, reflexo, sericeo, demum glabrato, subferrugineo, margine stratoque intermedio filamentosis aureis; hymenio pallidiore, setulis pubescente; setulis conico-acuminatis, 80–130×10–14 μ; sporæ ellipsoideæ, olivaceæ, 5–6×3 μ.—*Lév. in Ann. Sci. Nat.* sér. 3, v. p. 152; *Cooke, Grev.* viii. p. 145.—Stereum tabacinum, *Fr. Epicr.* 550; *Hym. Eur.* p. 641; *Berk. Outl.* p. 271. Thelephora tabacina, *Fr. Syst. Myc.* i. p. 437. Auricularia tabacina, *Sowerby*, t. 25. Helvella nicotiana, *Bolton*, t. 174.—*Exs.*: Sib. Pl. Crypt. Ard. fasc. ii. 121; Oudem. Fung. Neerland. 240; Fuckel, Fung. Rhen. 1318; Thum. Fung. Austr. 1211; P. Karst. F. Fenn. 130; Ellis, N. Amer. Fung. 13; Berk. Brit. Fung. 248; Desm. Crypt. France, sér. i. 415.

On trunks, &c. Britain; Europe; N. America; Arctic America; Patagonia; Vancouver's Island; Malacca; Australia (Victoria).

Readily distinguished by the bright golden-yellow margin and the coloured spores. Sometimes almost completely covering the underside of fallen logs. When moist dirty ferruginous passing to mulberry colour. Rigid when dry, adnate, with margin broadly free all round, and more or less lobed, or free and reflexed above, rugulose. Hymenium ferruginous with a purple or vinous tinge, or sometimes obscure cinnamon, often minutely cracked in lines radiating from the centre, or from several starting points in broadly effused specimens.

HYMENOCHÆTE TUBERCULOSA, *Cooke.* Tota resupinata, crassa, durissima, tuberculosa, purpureo-umbrina, rimosa, subtus ferruginea; setis sparsis, rigidis, acutis, 40–60×10–12 μ; sporæ ellipsoideæ, olivaceæ, 10×5 μ.—*Cooke, Grev.* ix. p. 101. (Type in Herb. Kew.)

On bark. Rio Janeiro.

Extending in a thick hard tuberculated crust for several inches. Most nearly related to *H. corticolor*, Berk. & Curt., but thicker, harder, and different in colour. (*Cooke.*)

Very broadly effused, thick, rigid when dry; hymenium coarsely tuberculose, cracked, brownish cinnamon with sometimes a tinge of purple.

Hymenochæte rhabarbarina, *Massee.* Effusa, arcte adnata; hymenio velutino, rhabarbarino, margine angusto pallido evanido; setulis acuminatis, 30–40 × 7–9 μ; sporæ dilute olivaceæ, oblongo-ellipsoideæ, 8 × 4 μ.—Corticium rhabarbarinum, *Berk. & Broome in Journ. Linn. Soc.* (*Bot.*), xiv. p. 69. (Type in Herb. Berk. n. 3987.)

On dead wood. Ceylon; New Zealand.

Closely adnate, broadly effused, springing from radiating fibres, new pilei springing from the first formed hymenium. When old the hymenium is often glabrous and cracked.

††† *Setæ subclavatæ, interdum asperulæ.*

Hymenochæte scabriseta, *Cooke.* (Pl. V. f. 7.) Resupinata, purpureo-fusca, mollis, subspongiosa, margine pallidiore, tenuiore, demum leviter libero; hymenio velutino, levi; setis clavatis, superne asperatis, pallide brunneis, 70–90 × 8–11 μ; sporæ ellipsoideæ, 7 × 4 μ.—*Cooke, in Rav. Fung. Amer.* n. 717. (Type in Herb. Kew.)—*Exs.*: Gav. Fung. Amer. 717; Ellis, N. Amer. Fung. 1108.

On bark of *Myrica.* Darien, Georgia, U.S.

Closely allied to *H. umbrina*, but distinguished by the rough clavate setæ.

Hymenochæte umbrina, *Massee.* Subimbricata, supra breviter reflexa, margine subiculoque luteis spongioso-tomentosis; hymenio umbrino, velutino; setulis elongatis, obtusis, verruculosis, brunneis, 30–40 × 7–8 μ; sporæ subglobosæ, 5 × 4 μ.—Stereum umbrinum, *Berk. & Cooke in Grev.* i. p. 164. (Type in Herb. Berk. n. 3857.)

Imbricated, free portion narrow; hymenium minutely velvety; the whole plant soft and spongy.

Hymenochæte fimbriata, *Ellis & Everh.* (Pl. V. f. 8.) Resupinata, suborbicularis, margine umbrino-brunneo strigoso-fimbriato; hymenio griseo, velutino; setulis cylindraceis vel subclavatis, pallidis, 50–70 × 8–10 μ; sporæ ellipsoideæ, hyalinæ, 10–12 × 5–6 μ.—*Ellis & Everh. Journ. Myc.* i. p. 149. (Authentic specimen from Peck in Herb. Kew.)

On branches of *Pinus Murrayana*. United States.

A very beautiful species, characterized by the laciniato-fimbriate margin, grey hymenium, pale cylindrical or subclavate setæ, and the large spores.

HYMENOCHÆTE DREGEANA, *Massee*. Effusa, resupinata, papyracea e matrice separabile ochroleuca, supra subtiliter tomentosa; hymenio rimosiusculo, papillato; setulis sparsis, tenuibus, cylindraceis, pallidis, 15–20 × 5–7 μ; sporæ ellipsoideæ, 7 × 5 μ.—Corticium Dregeanum, *Berk. in Hook. Lond. Journ. Bot.* v. p. 3. (Type in Herb. Berk. n. 3956.)

On bark. S. Africa.

Forming effused ochroleucous somewhat elongated patches, 3–4 inches long, 1½ inch broad, separable from the matrix, above minutely tomentose; hymenium glabrous, minutely mealy, rather rugged papillose, slightly cracked. Resembling somewhat *Corticium molle*, but easily known by its thicker flexible substance, which is separable from the matrix. (*Berkeley*.)

A true *Hymenochæte*; the setæ are slender, scattered, and almost colourless, and sometimes rather rough with minute particles of lime as in *Peniophora*.

HYMENOCHÆTE CERVINA, *Berk. & Curt.* Tota resupinata, effusa, tenuis, margine tomentoso cito obliterato; hymenio cervino; setulis pallidis, clavatis, 40–50 × 15–16 μ; sporæ ellipsoideæ, 5 × 4 μ.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 334. (Type in Herb. Berk. n. 3720.)

On bark and wood. Cuba; Carolina.

Thin, often much cracked and margin almost indeterminate; setæ pale, clavate or fusiform.

HYMENOCHÆTE CRASSA, *Berk.* *H.* pileo resupinato, coriaceo, tomentoso-velutino, pallidè rufo, ambitu crasso, demum libero; hymenio inæquali, velutino, concolore; setulis conicis vel subclavatis, interdum asperulis, 70–130 × 7–14 μ; sporæ cylindraceo-ellipsoideæ, 7–8 × 4 μ.—*Berk.*; *Cooke, Grev.* viii. p. 148.—Thelephora crassa, *Lév. Voy. Bonite*, t. 139, f. 1 B. (Specimen from Lév. herb., in Herb. Berk. n. 3829.)

On trunks. Britain; Cochin China; Australia (Clarence River).

HYMENOCHÆTE BOLTONI, *Cooke*. *H.* pileis effusis reflexisque, sæpius aggregatis, ochraceo-fuscis, tomentosis, margine albicante,

undulato; hymenio sordide ochraceo-cinereo, minutissime velutino, denique rimuloso; setulis pallide brunneis, asperulis, subfusiformibus, 50–100 × 5–6 μ; sporæ ellipsoideæ, 7–8 × 4–5 μ.—*Cooke, Grev.* viii. p. 145.—Stereum (Apus) Boltonii, *Sacc. Michelia*, ii. 239. Corticium cinereum, f. reflexum et f. resupinatum, *Sacc. Myc. Ven.* n. 404 & 405; *Fung. Ven.* ser. v. p. 165. —*Exs.*: Sacc. Myc. Ven. 1113.

On dead trunks. Italy.

Thick behind, becoming thinner towards the crisped margin, densely strigose, with a broad raised ochraceous marginal zone; hymenium umber with purple tinge, becoming ochraceous at the margin, cracked, minutely velvety.

HYMENOCHÆTE ABIETINA, *Massee.* Suberoso-coriacea, rigida, pileo effuso, applanato (subtus) tomentoso, ferrugineo-umbrino, ambitu determinato (reflexo marginatoque haud viso); hymenio velutino, fusco-ferrugineo; setulis cylindraceo-clavatis, interdum flexuosis, 80–150 × 7–8 μ; sporæ ellipsoideæ, 7 × 4–5 μ.—Stereum abietinum, *Fr. Epicr.* 553; *Hym. Eur.* 643. Thelephora abietina, *Pers. Syn.* p. 573; *Fr. Syst. Myc.* i. p. 442.—*Exs.*: P. Karst. Fung. Fenn. 943; Thuem. Myc. Univ. 1107.

Hymenium sometimes with a purple tinge.

HYMENOCHÆTE SCHOMBURGKII, *Massee.* E resupinato reflexa, suborbicularis, demum conchiformis, umbrina antice subzonata, velutina; hymenio levi concolore; setulis flaccidis, pallide brunneis, cylindraceis vel fusiformibus, 50–100 × 6–7 μ; sporæ subglobosæ, 4 × 3 μ.—Stereum Schomburgkii, *Berk. Austr. Fung.* n. 134. (Type in Herb. Berk. Kew. n. 3778.)

On wood. Port Darwin, Australia.

Pileus about an inch broad.

HYMENOCHÆTE PURPUREA, *Cooke et Morg.* Coriaceo-spongiosa, tota resupinata, arcte adnata, margine byssino; hymenio purpureo, in brunneolum vergente, velutino; setulis clavato-fusoideis, leviter asperulis, 60–150 × 10–12 μ; sporæ ellipsoideæ, 7 × 4–5 μ.—Thelephora purpurea, *Cooke & Morg. Mycol. Fl. Miami Valley*, p. 198. (Type in Herb. Kew.)

On wood. United States; Australia (Melbourne); Norfolk Island.

Hymenium brownish purple or sometimes with a cinnamon

tinge, margin paler, fibrillose or byssoid. Broadly effused, following the irregularities of the matrix, rather thin; texture soft and spongy, lilac, becoming paler as is frequently the case with the hymenium; sometimes when old altogether dirty cinnamon.

HYMENOCHÆTE OLIVACEA, *Cooke*. Effusa, atro-olivacea, rugosa, velutina, margine tenuiore pallidiore; setis cylindraceis vel subclavatis, pallidis, $40–60 \times 8–10\ \mu$; sporæ ellipsoideæ, $6 \times 4\ \mu$.—*Grev.* xiv. p. 11. (Type in Herb. Kew.)

On branches. Australia (Toorvoomba).

Somewhat resembling *H. umbrina*, but distinguished by the pale byssoid or fibrillose margin and the different spores.

HYMENOCHÆTE KALCHBRENNERI, *Massee*, n. sp. Brunnea, crassiuscule membranacea, late effusa, laxe matrici adnata; margine subdeterminata, repanda; hymenio velutino; setulis cylindraceis vel subclavatis, interdum asperulis, $80–90 \times 6–8\ \mu$; sporæ ellipsoideæ, $7 \times 4–5\ \mu$.—*Exs.*: (Thuem. Myc. Univ. 1504) under the name of *Corticium murinum*, comm. P. Karst.

On dead trunk of *Eucalyptus*. Australia (Victoria).

Broadly effused, thin, almost separable; hymenium velvety, brown, with sometimes a tinge of purple. Setæ coloured, thin-walled, blunt, or sometimes slightly incrassated upwards, and in some instances more or less rough with minute granules of lime.—*Corticium murinum*, Berk. & Curt., is a *Coniophora*.

HYMENOCHÆTE MODESTA, *Massee*. Orbicularis, demum confluendo-lobata, contextu pallido subluteo, margine breviter byssoideo; hymenio luteo-griseo; setulis pallidis, obtusis, $20–30 \times 8\ \mu$; sporæ oblongo-ellipsoideæ, $8 \times 6\ \mu$.—Corticium modestum, *Berk. & Broome in Journ. Linn. Soc. (Bot.)* xiv. p. 69. (Type in Herb. Berk. n. 3962.)

On dead wood. Ceylon.

Commencing as small circular patches, which soon become confluent; margin byssoid or sometimes radiato-strigose; hymenium ochraceous with ashy tinge, margin paler; setæ small, pale, not numerous.

IV. *Veluticeps*. *Setæ fasciculatæ*.

HYMENOCHÆTE VELUTICEPS, *Berk.* Dimidiata, dura, coriacea, sulcato-zonata, velutina, glabrescens; pileo brunneo; hymenio

stratoso, pallide cinnamomeo; setis fasciculatis, brunneis, flexuosis, fasciculis 150–200 μ long.; sporæ ellipsoideæ, 6–7 × 4–5 μ.—*Berk. in Journ. Linn. Soc. (Bot.)* x. p. 333.—Veluticeps Berkeleyi, *Cooke*, *Grev.* viii. p. 149. (Type in Herb. Berk.)

On logs in woods, often on the underside. Cuba.

The fasciculate setæ, at first sight, make it look like an *Hydnum* allied to *H. flavum* (Berk.).

Hymenochæte vibrans, *Massee.* Centro affixa, orbicularis, coriacea, rigida; pileo ferrugineo, zonato, velutino nec striato; hymenio velutino; setulis e hyphis tenuibus, septatis, compositis; sporæ ellipsoideæ, 5–6 × 3 μ.—Stereum vibrans, *Berk. & Curt. in Journ. Linn. Soc. (Bot.)* x. p. 332. (Type in Herb. Berk. Kew. n. 3709.)

On dead wood. Cuba.

Resembling a species of *Hirneola* in habit and general appearance, but not gelatinous, and having the hymenium minutely velvety, the pile consisting of hairs composed of a bundle of thin septate hyphæ; 2–3 inches across; hymenium cinnamon with a silky sheen. Not a typical *Hymenochæte.*

Corticium, *Fries* (emend.).

Hymenium amphigenum, læve vel tuberculosum, ceraceum, glabrum, e mycelio immediate enatum absque strato intermedio; sporæ albæ.—*Fr. Epicr.* p. 556 (in part). *Thelephora* (in part) of most old authors.

As defined above, the leading features of the genus are:—The hymenium covering the whole free surface of the plant, which is closely adnate by the entire under surface to the substratum; in the more highly developed species the extreme margin is free, and sometimes more or less upraised. The hymenium is perfectly glabrous and waxy, owing to the entire absence of projecting cystidia, which give to the hymenium a velvety or minutely hispid appearance in the genera *Peniophora* and *Hymenochæte.*

The genus *Hypochnus* of Fries is without doubt composed of abnormal states of species of *Corticium,* as clearly illustrated by *Corticium arachnoideum,* which, as described by Berkeley, is a *Hypochnus,* with a loose, felted subiculum, mostly barren, with here and there a few scattered basidia, or in some instances with scattered patches of hymenial surface; but specimens collected

by Berkeley since the species was first established show every transition from the Hypochnoid form to that of a perfect *Corticium*, with a waxy thin hymenium extending continuously for several inches.

A. *Ambitu libera, determinata, marginata.*

Corticium salicinum, *Fr.* (Pl. VI. fig. 1.) Coriaceum, molle, siccum rigidum, centro adfixum, margine ubique reflexo, extus albo-villosum; hymenio persistenter sanguineo-rubro, sicco contiguo; sporæ cylindraceo-ellipsoideæ, curvulæ, 14–16 × 5–6 μ.—*Fr. Hym. Eur.* 647; *P. Karst. Myc. Fenn.* 310; *Wint. Krypt. Fl.* 339; *Stev. Brit. Fung.* 273; *Ic. Sel. Hym. Fenniæ, P. Karsten*, p. 6, f. x.—Thelephora cruenta, *Alb. et Schw.* 277. Peziza sarcoides, *Wahlenb. Fl. Lapp.* n. 1078. (Specimen from Fries, in Herb. Berk. n. 3953.)—*Exs.*: Fuckel, F. Rhen. 1593; Thuem. Myc. Univ. 114; Ellis, N. Amer. Fung. 609; P. Karsten, Fung. Fenn. 42 and 316.

On willow, rarely on poplar. N. Europe (Forres, N.B.); N. America.

Pezizoid when young, often becoming effused and irregular, but margin always upturned. Hymenium smooth, blood-red, white below, minutely villous or pulverulent, due to minute crystals, often becoming almost glabrous. When dry thin and subcartilaginous.

Corticium deglubens, *Berk. & Curt.* Tenue, papyraceum, secernibile, subtus candidum; hymenio lævissimo, ochraceo; sporæ ellipsoideæ, 10 × 6–7 μ.—*Berk. & Curt. in Grev.* i. p. 166. (Type in Herb. Berk. n. 3955.)

On juniper. Alabama.

"At first resupinate, with a very narrow white byssoid margin, soon detached, white beneath, like kid leather; hymenium honey-coloured, very even and continuous." (*Berkeley.*)

Margin fibrillose, wholly separable as a thin firm pellicle; hymenium waxy, continuous, brownish ochre.

Corticium evolvens, *Fr.* (Pl. VI. fig. 4.) Resupinatum, marginatum vel effuso-reflexum, molle, subtus tomento albido flocculosum, azonum; hymenio nudo, glabro, subrugoso, fusco-expallente, siccitate rimoso-partito; sporæ ellipsoideæ, 10–12 × 5 μ.—*Fr. Hym. Eur.* p. 646; *Cooke, Handb.* i. 320; *Stevens, Brit.*

Fung. 273; *Fl. Dan.* t. 840; *Wint. Krypt. Fl.* 339.—*Exs.*: Welw. Crypt. Lusitan. n. 70; Ellis, Fung. N. Jersey, n. 3491.

On bark. Britain; Europe.

Springing very often as independent minute rounded patches, which sometimes assume a saucer-like form and remain solitary; more frequently several become confluent, and form irregular patches with the margin more or less upraised and fibrillose below; hymenium dirty ochraceous with sometimes lilac tints, cracked when dry and showing the fibrillose subiculum. Frequent on cherry, mountain ash, and species of *Prunus.*

Corticium hepaticum, *Berk. & Curt.* Latissime effusum; margine hic illic reflexo, tenui, subtus albido; hymenio continuo hepatico; sporæ oblongo-ellipsoideæ, 12×4–$5\ \mu$.—*Berk. & Curt. in Grev.* i. p. 180. (Type in Herb. Berk. n. 4056.)

On ash. Penns., U.S.

Very widely effused, running over the rough wood, and surrounding any projecting point; edge thin, white beneath, here and there free; hymenium liver-coloured, with somewhat the aspect of that of *C. viscosum* or *C. lividum* when dry. (*Berkeley.*)

Broadly effused, thin, liver-coloured, rigid and cartilaginous when dry; not a good *Corticium*, villous below; probably a species of *Auricularia.*

Corticium subrepandum, *Berk. & Cooke.* Subcoriaceum, primo pezizoideum, orbiculare, demum applanato-confluentum; hymenio marginato, subochraceo, sicco rimoso, margine libero; sporæ late ellipsoideæ, basi apiculatæ, 12×7–$8\ \mu$.—*Berk. & Cooke in Grev.* vi. p. 81. (Type in Herb. Kew.)

On rotting wood. Newfield, U.S.

Allied to *C. ochroleucum.* The small orbicular patches are soon confluent to the extent of an inch or two, the margin being free and elevated in drying, by which process the hymenium is also cracked in a tessellate manner. (*Berkeley & Cooke.*)

White, becoming pale greyish-olive or subochraceous, rigid.

Corticium epichlorum, *Berk. & Curt.* *C.* subiculo tenui viridi-luteo marginem angustum formante; hymenio olivaceo-umbrino demum rimoso; sporæ ellipsoideæ, $6 \times 4\ \mu$.—*Berk. & Curt. in Grev.* i. p. 178. (Type in Herb. Berk. n. 4081.)—Corticium simulans, *Berk. & Rav. MS.*—*Exs.*: Rav. F. Car. 25; Rav. F. Am. 10; Thuem. Myc. Univ. n. 512. (*Non* C. simulans, *Berk. & Broome.*)

On wood of *Vaccinium*. United States.

"Subiculum thin, yellowish green, forming a slight margin hymenium olive-umber, at length cracked." (*Berkeley*.)

Berkeley first gave the name of *C. simulans* to the present plant, without, however, publishing the description, which was afterwards published as *C. epichlorum*, Berk. & Curt. Thin, broadly effused, margin sometimes byssoid, yellow or greenish; hymenium brownish olive or dirty cinnamon, minutely cracked, or sometimes much torn by contraction.

CORTICIUM FLOCCULENTUM, *Fr.* Ceraceo-molle, primo pezizoideum, extus albo-byssinum, dein dilatatum, effusum, applanatum; hymenio marginato, interdum tuberculoso, sanguineo-rufo, sicco rimoso, pruina cervino; sporæ cylindraceo-ellipsoideæ, 8×4 μ.—*Fr. Epicr.* p. 599; *Hym. Eur.* p. 647; *Fuckel, Symb.* p. 28; *Wint. Krypt. Fl.* n. 338.—*Exs.*: Thuem. Fung. Austr. n. 220; Sydow, Myc. March. n. 409?

On poplar bark and wood. N. Europe.

Appearing as minute cupulate patches, which become expanded and sometimes confluent; under surface minutely downy; hymenium deep brownish red, sometimes dirty lilac.

Closely resembles young form of *Stereum purpureum*, the only point of difference consisting in the absence of pruina on the hymenium of the latter.

CORTICIUM MUSCIGENUM, *Berk. & Broome.* Primum tenue margine albo-tomentoso, demum incrassatum margine elevato; contextu molli, albo; hymenio obscure ochraceo; sporæ oblongo-ellipsoideæ, 7×5 μ.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 71. (Type in Herb. Berk. n. 3963.)

Running over mosses. Habgalla, Ceylon.

Hymenium ochraceous, polished; substratum thick, fibrillose, white.

"Looks like a mass of plaster which had fallen on the moss."

CORTICIUM NYSSÆ, *Berk. & Curt.* Adnatum, pileo utrinque reflexo ochroleuco velutino glabrescente; margine inflexo; hymenio lævissimo latiore; sporæ ellipsoideæ, 7×3 μ.—*Berk. & Curt. in Grev.* i. p. 166. (Type in Herb. Berk. n. 3695.)

On branches of *Nyssa*. Pennsylvania; California.

"Spreading for some inches in length, 2 inches across; pileus

with a deep groove, ochraceous, velvety; margin, at least in the dry plant, incurved; hymenium very even and continuous, of a redder tint." (*Berkeley.*)

Thick, rigid, hymenium horny, when dry brownish ochre; margin free, villous below and ochraceous.

CORTICIUM POROSUM, *Berk. & Curt.* Resupinatum, lacteum, hic illic porosum, margine libero reflexo; sporæ, oblongo-ellipsoideæ, 7 × 4 μ.—*Berk. & Broome in Ann. Nat. Hist.* ser. 5, iii. 1879, p. 211. (Type in Herb. Berk. n. 4034.)

On wood. Venezuela; Aboyne, N.B.

"The pores look as if little dewdrops had settled on the hymenium, which had in consequence contracted or, rather, retracted." (*Berk. & Broome.*)

Rather thick, adnate, margin often byssoid and indeterminate, but sometimes defined and slightly free; often sterile, then spongy and porous; hymenium, when well developed, waxy, even, pallid when dry, retracted or dried up in parts in rounded spots, often much cracked into large pieces, gaping, the edges curling up.

CORTICIUM PAUPERCULUM, *Berk. & Curt.* Parvum, orbiculare, gilvum, margine juniore pallidiore, adulto elevato; hymenio ceraceo, rimoso; sporæ ellipsoideæ, 8 × 4 μ.—Hymenochæte paupercula, *Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 334. (Type in Herb. Berk. 4066.)

On Congo bean. Cuba; United States.

Forming small, very thin patches, which often become irregularly confluent, pale ochre with a pink tinge; hymenium in perfect specimens waxy and cracked.

CORTICIUM POPULINUM, *Fr.* Molle, tuberculiforme, mox confluendo-effusum, demum involutum marginatum, subtus albo-tomentosum; hymenio colliculoso cinerascenti-ferrugineo; sporæ subglobosæ, 7–8 μ diam.—*Fr. Epicr.* p. 559; *Fr. Hym. Eur.* p. 648.—Thelephora populina, *Sommerf. Lapp.* p. 183.

I have once met with a plant growing on poplar, which agreed exactly with the description given by Fries. Commencing as minute silky patches springing from old Sphærias; margin involute, hymenium ferruginous. Readily distinguished from allied species by the subglobose spores.

On poplar. Britain (Scarborough); N. Europe.

Corticium salmonicolor, *Berk. & Broome.* Pusillum, centro adnatum, ambitu byssoideo, libero; hymenio pallide carneo, rimoso-areolato; sporæ ellipsoideæ, $4 \times 2\,\mu$.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 71. (Type in Herb. Berk. n. 3968.)

On dead wood. Ceylon.

In small patches, circular or irregular, fixed by the centre; margin free and usually more or less upturned, and often undulate; rigid when dry.

Corticium sarcoides, *Fr.* Subcarnosum, molle, siccum collapsum, flaccidum, e cupulari explanatum, centro adnatum, extus adpresse villosum; hymenio obscure carneo interdum tuberculoso, sicco expallente, rimoso; sporæ ellipsoideæ, $5\text{–}6 \times 3\text{–}4\,\mu$.—*Fr. Hym. Eur.* p. 647; *P. Karst. Myc. Fenn.* 311; *Wint. Krypt. Fl.* 339. Thelephora sarcoides, *Fr. Elench.* p. 185. Thelephora cruenta, *β*, *Alb. & Schw.* (Specimen from Fries in Herb. Kew.)

On branches, especially birch. N. Europe.

Breaking through the epidermis in minute circular patches, some of which become saucer-shaped and remain isolated; the majority soon become confluent and form an irregular patch, the component plants being for a long time distinguishable, and are generally more or less tuberculose in the centre, margin closely adnate. Hymenium cracked, often concentrically.

Corticium Lycii, *Cooke.* Effusum, tenue; margine pallido, libero, subbyssoideo; hymenio lilacino, contiguo; sporæ ellipsoideæ, $8 \times 4\,\mu$.—*Cooke, Grev.* ix. p. 95.—Thelephora Lycii, *Pers.*—*Exs.*: Rab. Fung. Eur. 1608; Rab. Wint. Fung. Eur. 2822; Desm. Crypt. France, sér. i. 119; Thuem. Fung. Austr. 1113.

On *Lycium* and *Syringa vulgaris.* Britain (Kew); Europe.

Usually commencing as small round patches which become confluent; margin generally more or less free, but not invariably so; hymenium bright lilac, when old often with a tinge of ochre.

Corticium rimosissimum, *Berk. & Curt.* Late effusum, resupinatum, cinnamomeum, a matrice separabile, rimosissimum, contextu rufo-albido; sporæ ellipsoideæ, $6 \times 4\,\mu$.—*Fung. N. Pacific Expl. Exp.* n. 110. (Type in Herb. Berk. Kew. n. 4053.)

On dead leaves. Nicaragua; Bombay.

Broadly effused on thin branches, thin, margin indeterminate or byssoid and free.

Corticium scariosum, *Berk. & Broome.* Ochroleucum, scariosum; hymenio glabro e mycelio arachnoideo oriundo, demum subsecernibile; sporæ globosæ, 7–8 μ diam.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 71.—Corticium scariosum, *Berk. & Curt. N. Amer. Fung.* n. 278. (Type in Herb. Berk. Kew. n. 3954.)

On dead wood. Ceylon; S. Carolina.

Consisting at first of very thin, white, arachnoid patches of mycelium which eventually give origin to a waxy hymenium in the centre.

Corticium tenuissimum, *Berk. & Broome.* Effusum, subsecernibile, suborbiculare, tenuissimum, subglaucum, margine albo annulo rufo cincto; sporæ oblongo-ellipsoideæ, 8×6 μ.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 71. (Type in Herb. Berk. n. 4082.)

On dead bark. Ceylon.

Very thin, 1–3 lines broad, silver-grey, separable.

Corticium antarcticum, *Speg.* *C.* pileis primo cupulato-erumpentibus, subcampanulatis, dein effuso-dilatatis, plus minusve matrici arcte lateque adnatis, ambitu liberis, reflexis (in sicco revolutis) sæpeque confluentibus, irregulariter anguloso-orbicularibus, 2–4 cm. diam.; coriacellis, crassiusculis, extus sordide castaneis v. subnigricanti-testaceis, azonis, glabris, non v. vix margine puberulis, acutis, sublobato-repandulis; hymenio plano, subceraceo, crassiusculo, corneo, in juventute albo pruinuloso, in sicco densiuscule rimuloso-diffracto.—*Speg. Fung. Fueg.* n. 191.

On fallen branches. Picton Island; Tierra del Fuego.

Corticium Boltonii, *Fr.* *C.* margine breviter reflexo, villoso, albo, subtus fusco-zonato; hymenio velutino, ferrugineo-fusco, sicco rimoso.—*Fr. Epicr.* p. 558; *Hym. Eur.* p. 647.

Fries considers the above species to be the same as the figure of Bolton, t. 166. f. *d*, whereas the figure is considered by Berkeley to represent *Stereum rugosum.* In the absence of specimens it is impossible to say to what genus Fries's plant belongs; the velvety hymenium points to *Hymenochæte*, as does also the colour.

On bark of cherry. Europe.

Corticium ciliatum, *Fr.* Effusum, e ceraceo cartilagineum, subtus umbrinum, ambitu determinato, nigro-strigoso, demum

liberato, involuto; hymenio glabro, carneo-fusco, sicco rimoso.—*Fr. Epicr.* p. 558; *Hym. Eur.* p. 653. Thelephora ciliata, *Fr. Elench.* p. 186. Thelephora corticalis, *Schrad.*?

On wood of beech. Sweden.

A little-known species, said by Fries to be related to *Peniophora quercina.*

Corticium? crispatum, *Speg.* *C.* pileis primo erumpentibus, subcampanulatis, parvulis, 0·5–1 cm. diam. dein applanato-expansis, sæpeque lineatum confluentibus 3–10 cm. long., 1–2 cm. lat. matrici arcte adnatis, coriaceis, subcrassiusculis, rigidulis, ambitu strictiuscule liberis, reflexis, 1–3 mm. dense grosseque lobato-repandis, extus testaceis pruinulosis v. puberulis, lobis contractulo-crispatis, obtusiusculis; hymenio plano v. spurie undulato tuberculatove, in juventute albo-pallescente, dein alutaceo, in senectute subfulvescenti-rufescente, carnoso-subceraceo, in sicco non v. vix hinc inde rimuloso.—*Speg. Fung. Fueg.* n. 94.

On rotten branches of beech. Slogget Bay, Tierra del Fuego.

Corticium contractum, *Fr.* Resupinatum, effusum, subrotundum, determinatum, ambitu siccitate soluto et contracto cupulare; hymenio ceraceo, levi, glabro, pallido (sicco contiguo).—*Fr. Nov. Symb. Myc.* p. 114.

On the ground on leaves and decaying vegetable matter. Mexico.

A fine species, evidently related to *Corticium giganteum*, Fr. (=*Peniophora gigantea*). (Fries.)

Corticium juniperinum, *Fr.* Subcoriaceum, tenax, centro adnatum, margine tenui, ubique reflexo, pubescente, pallido marginatum; hymenio rugoso-tuberculoso, carneo-cinereo.—*Fr. Epicr.* p. 559; *Hym. Eur.* p. 648; *Wint. Krypt. Fl.* p. 338.—Thelephora juniperina, *Fr. Elench.* p. 183; *Weinm. Ross.* p. 387.

On bark of junipers. Russia and Germany.

Distinguished from other species with a raised margin by being coriaceous.

Corticium microscopicum, *Speg.* Minutissimum, 1–3 mm. diam., tenue-membranaceum, coriacellum, rigidulum, subceraceum, cupulatum, scutato-adfixum, solitarium vel densiuscule gregarium sæpeque confluens; margine libero acutiusculo integro reflexo, extus fulvescente vel rufescente, glaberrimo, levissimo; hymenio

tenuissimo, cinereo, in prima ætate glauco-pruinuloso.—*Speg. Fung. Fueg.* p. 41, n. 100.

On fallen rotten beech-branches. In woods near Jandagaja; Tierra del Fuego.

In details and habit very similar to *Calloria epipora.*

Corticium majusculum, *Speg.* Coriaceo-membranaceum, primo suborbiculare, scutato-adnatum, centro umbonatulum, densiuscule gregarium, dein confluens, late effusum, matrici laxe adnatum, margine repando-lobato, sæpe reflexo, extus villosulo ligneo v. albo-fulvescente donatum; hymenio in vivo tenui, submucedineo, sordide albo, in sicco subevanescente, levi non v. vix hinc inde scrupuloso, sæpe obsoletissime denseque zonato, rimis majusculis labiis revolutis, sordide fusco.—*Speg. Fung. Fueg.* n. 99.

Very common on rotten beech-wood. Staten Island and in the whole of Tierra del Fuego.

Corticium pulchellum, *Speg.* Resupinatum, tenue-membranaceo-cartilagineum, tenax, late effusum, atque matrici laxe adnatum, margine determinato, subreflexo, lobato-caperato, crassiusculo donatum, subtus lilacino-fuscescens, glaberrimum, subsericeo-nitens; hymenio glabro, levi, amœne albo-roseo vel roseo-lilacino.—*Speg. Fung. Argent.* Pug. iii. n. 18.

On decayed trunks of *Duvaya longifolia.* Argentine Republic.

Corticium crinitum, *Fr.* Molle, effusum, rotundatum, submarginatum, subtus olivaceum, azonum, setoso-hispidum; hymenio glabro, pallescente, rimoso.—*Fr. in Linnæa,* v. p. 529; *Epicr.* p. 558.

On trunks. Brazil.

Hairs on the under surface resembling those on the pileus of *Trametes hydnoides.*

Corticium pannosum, *Fr.* Late resupinato-expansum, adnatum, ramos ambiens, cinereo-luridum, ambitu fibris stipatis erectis fuscis pannoso; hymenio inæquabile cinereo-lurido, siccitate rimosissimo.—*Fr. Nov. Symb. Myc.* p. 114.

On fallen branches. Mexico.

With the habit of *Corticium cinereum,* but receding from all known species of *Corticium* in the elegant fringe composed of

slender fibres densely crowded and forming a border, and not marginate only as in *Corticium crinitum*.

Corticium triviale, *Speg.* Crassiuscule membranaceum, planum, late effusum, laxe matrici adnatum, leve v. spurie tuberculato-undulatum, margine non v. vix attenuatum, determinatum sed non reflexum, repandulum, lobatum, subtus intusque album, supra (hymenio) carneum v. aurantium, in juventute subpruinulosum et mucedineo-ceraceum, siccum tenacellum, rigidulum, non rimosum, vix hinc inde v. ambitu contracto-lacerum ac reflexulum.—*Spegazzini, Fung. Fueg.* n. 98.

On rotten decorticated beech. Tierra del Fuego.

A common species, variable in shape, often resembling a starved form of *Stereum rugosum*; sterile, hymenium studded with minute crystals of oxalate of lime, 15–20 μ diameter.

Corticium versiforme, *Fr.* Ceraceum, primo molle, dein induratum, e cupulari tuberculiforme, marginatum, inæquale, rubrum, leviter albo-pruinosum.—*Fr. Epicr.* p. 559; *Hym. Eur.* p. 647; *Wint. Krypt. Fl.* p. 338.—Thelephora versiforme, *Fr. Elench.* p. 184.

On bark and wood of *Acer*. N. Europe.

Commencing as scattered cupulate spots, usually becoming confluent, broadly effused, and immarginate; when old and dry transversely rimose and pale, and not at all resembling the early stage.

B. *Immarginata, ambitu subtusque byssina vel strigosa.*

* *Hymenio albo vel ochraceo.*

Corticium seriale, *Fr.* Elongato-effusum, adglutinatum ceraceo-molle, indeterminatum, ambitu byssino subalbicante; hymenio inæqualiter papilloso albo-pruinoso, rimoso, siccitate sordide ochraceo; sporæ cylindraceo-oblongæ, utrinque obtusissimæ, 13–14 × 6–7 μ.—*Fr. Epicr.* 563; *Fr. Hym. Eur.* 653. Thelephora seriata, *Fr. Syst. Myc.* p. 445. (Specimen from Fries in Herb. Berk. n. 3992.)

On pine-wood. Europe.

Broadly effused, subindeterminate, or entirely so, thin, margin fibrillose, whitish; hymenium in the dry specimen dirty ochraceous.

Corticium calceum, *Fr.* Late effusum, adglutinatum, ceraceum, glaberrimum, album, ambitu similari; hymenio lævi, sicco rimoso, pallido; sporæ cylindraceo-ellipsoideæ, 8×4 μ.—*Fr. Hym. Eur.* p. 652; *Berk. Outl.* 274; *Cooke, Handb.* i. 323; *Stevens. Brit. Fung.* 277; *Wint. Krypt. Fl.* 335; *P. Karst. Fung. Fenn.* 314. (Specimen from Fries in Herb. Berk. Kew. 3987.)—*Exs.*: Rav. Fung. Amer. 126, 227, & 720; Ellis, Fung. N. Jersey, 3139 & 3156; Fuckel, Fungi Rhenani, 1308; P. Karst. Fung. Fenn. 133 & 953; Roum. Fung. Gall. Sel. 506, 802, & 2511; Thuem. Fung. Austr. 824, 923, & 720; Rav. Fung. Car. 4; Thuem. Myc. Univ. 807.

On wood. Britain; Europe; N. America; Cuba; Venezuela; Cape of Good Hope.

Thin, effused, margin determinate; hymenium smooth, polished, pallid, whitish with tinge of lilac, or pale ochre when dry, sometimes continuous, at others cracked.

Corticium serum, *Fr.* Late effusum, incrustans, tenue, album, recens carnosum, glabrum, pruinosum, dein siccatumque flocculoso-fatiscens, papillis rotundis, congestis, æqualibus; sporæ ellipsoideæ, 12–15×8–9 μ.—*Fr. Hym. Eur.* 652; *Wint. Krypt. Fl.* 328; *Stevens. Brit. Fung.* 283; *P. Karst. Myc. Fenn.* 320.—Thelephora sera, *Pers. Syn.* 580. Lyomyces serus, *P. Karst. Rev. Myc.* iii. p. 23.—*Exs.*: Thuem. Myc. Univ. nn. 1909 and 2206; Roum. Fung. Gall. 2211.

Effused, adnate, very fibrous below, and frequently so all over when barren; hymenium when perfect waxy, cracked; margin radiating, byssoid, pallid ochraceous when dry.

Corticium sebaceum, *Massee.* Effusum, carnoso-ceraceum, induresceus, incrustando versiformis tuberculoso vel stalactitia, albida, ambitu similari; hymenio collabente, flocculoso-pruinoso; sporæ ellipsoideæ, basi apiculatæ, 14–16×7–9 μ.—Thelephora sebacea, *Fr. Hym. Eur.* 637; *Berk. Outl.* t. 17. f. 6; *Fl. Dan.* t. 1302; *Cooke, Handb.* n. 904. Thelephora sebacea *et* incrustans, *Pers. Myc. Eur.* i. p. 135.—*Exs.*: Fuckel, Fung. Rhen. 1324; Roum. Gall. 2805; Thuem. Myc. Univ. 2009.

On the ground, or running up grass, twigs, and various substances. Britain; Europe; N. America.

Whitish, rather pulpy when fresh; the hymenium, when perfectly formed, smooth and waxy, becoming pallid when dry.

CORTICIUM SCUTELLARE, *Berk. & Curt.* Resupinatum, late effusum, immarginatum, ex albido subalutaceum; hymenio in areolas minutas fisso; sporæ ellipsoideæ, 5×3 μ.—*Berk. & Curt. in Grev.* ii. p. 4. (Type in Herb. Berk. Kew. n. 4013.)—*Exs.*: Ellis, Fung. N. Jersey, 3501 & 3500; Ellis, Fung. N. Amer. 977.—Ellis, N. Jers. Fung. 3399, is a *Coniophora*.

On wood and herbaceous stems. Britain; United States; Venezuela.

Widely effused, thin, inseparable, immarginate; hymenium from dirty white to tan-coloured or tawny. Adnate, broadly effused; hymenium waxy, smooth, very much cracked into minute areolæ, pallid or pale ochraceous; margin almost indeterminate.

CORTICIUM SUBCONTINUUM, *Berk. & Curt.* Late effusum, membranaceum, ochraceum, immarginatum, læve, glabrum, intus brunneum, revivescens; sporæ ellipsoideæ, 6×3–4 μ.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 337. (Type in Herb. Berk. n. 4039.)

On bark. Cuba.

Broadly effused, thin, waxy, bright ochre; cracking due to matrix.

CORTICIUM SIMULANS, *Berk. & Broome.* Molle, fulvum, e strato albo floccoso membranaceo oriundum; hymenio lævissimo; sporæ oblongo-ellipsoideæ, 8×4 μ.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 72.—*Exs.*: Thuem. Myc. Univ. 512; Rav. Fung. Amer. 10; Rav. Fung. Car. 25. (Type in Herb. Berk. 3969.)

Ceylon; United States.

Running over mosses and twigs; margin irregular, irregularly radiato-fibrillose; hymenium waxy, ochraceous or fulvous. "At first sight resembling *Merulius Corium*."

CORTICIUM RUDE, *P. Karst.* Subrotundum, confluens, tomentosum, molle, adnatum, album, ambitu similari; hymenio ceraceo, tenuissimo, contiguo, sicco vix rimoso, in alutaceum leviter vergente, levi, epapilloso; sporis ellipsoideis, vulgo uniguttulatis, 4×2–3 μ.—*P. Karst. Symb. Myc. Fenn.* ix. p. 53.

On bark of *Abies excelsa*. Finland.

Generally very much wrinkled. Related to *Corticium molle*.

CORTICIUM RORIDUM, *Speg.* Late effusum, ceraceo-incrustans, tenue, flavescenti-album vel alutaceum, margine attenuatum, repandum, lobatum, zona fibrillosa ac fimbriatula, latiuscula, pallescente vel alba cinctum; hymenio in juventute sulphureo-

pruinuloso, guttulis aqueis sordidis minutis insperso, levi, plano vel spurie ruguloso-tuberculoso.—*Speg. Fung. Fueg.* p. 41, n. 101.

On bark of *Fagus antarcticus*. Wood near Slogget Bay, Tierra del Fuego.

Corticium pellicula, *P. Karst.* Rotundatum vel effusum, subadnatum, ceraceo-membranaceum, valde tenue, indeterminatum, siccum rimoso-incisum, nonnumquam papillis minutis, irregulariter sparsis, glabrum, subtus subtiliter fibrillosum, ambitu similari vel obsolete flocculoso-furfuraceo, lacteo-niveum; sporis sphæroideis, raro ellipsoideo-sphæroideis, levibus, uniguttulatis, 6–8 μ diam., vel $8 \times 6\ \mu$.—*P. Karst. Symb. Myc. Fenn.* xiii. p. 5.—Athelia pellicula, *Chev. Fl. gén. Paris,* i. p. 85, t. 6. f. 1?

On bark of fallen branches of *Abies excelsa*. Finland.

Related to *Corticium granulosum*, Bon. Hyphæ 5–6 μ thick.

Corticium portentosum, *Berk. & Curt.* Ochroleucum, contextu crasso, albo, molli, spongioso; hymenio pallide ochraceo, tuberculato glabro; sporæ ellipsoideæ, 6×3–$4\ \mu$.—*Berk. & Curt. in Grev.* ii. p. 3. (Type in Herb. Berk. 4078.)—*Exs.*: Ellis. & Everh., N. Amer. Fung. ser. 2, n. 1715.

On wood. United States.

Forming a thick mass on very decayed wood, spreading widely; substance soft, white, spongy; hymenium tuberculate, smooth. Some parts, however, are free from tubercles. (*Berkeley.*)

Thick, pliant; hymenium nodulose, pale ochre when dry.

Corticium punctulatum, *Cooke.* Late effusum, tenue, indeterminatum, subtus ambituque albo-floccosum; hymenio primum punctulato, demum glabro, lævi, siccitate pallido vel ochraceo; sporis globosis, 10 μ diam.—*Cooke in Grev.* vi. p. 132. (Type in Herb. Kew.)

On pine chips, leaves, &c. Aiken, S. Carolina.

In Cooke's diagnosis the remark "persistenter niveum" does not appear to be correct, as the type specimen is now pale ochraceous. Spores very copious; plant thin, often cracked, and separating more or less as a film. Hymenium, when perfect, waxy, but generally imperfect and spongy. Allied to *C. arachnoideum*, Berk.

Corticium pallescens, *Massee.* Late effusum, adglutinatum, grumoso-cartilagineum, durum; hymenio spurie papilloso,

rimoso ex albido pallescente; sporæ globosæ, 7–8 μ diam. — Thelephora pallescens, *Schwein. Syn. N. Amer. Fung.* 665.

On trunks. United States. (Specimen from Schweinitz in Herb. Berk.)

Broadly effused, indeterminate, thick, much cracked when dry, pallid, with a tinge of pale red here and there. Resembling thick forms of *C. lactescens*. Schweinitz says it is commonest on scorched trunks.

CORTICIUM LEPRA, *Massee*. Candidum, tenue, adnatum, primum orbiculare, demum confluens; hymenio ceraceo, rimuloso; sporæ ellipsoideæ, 5×3 μ.—Stereum Lepra, *Berk. & Broome in Journ. Linn. Soc. (Bot.)* xiv. p. 67.

On dead wood. Central Province, Ceylon. (Type in Herb. Berk. Kew. n. 3836.)

Resembling *S. acerinum*, but far thinner and more inclined to separate from the matrix. (*Berk. & Broome.*)

Adnate, thin, extreme margin free; hymenium whitish, waxy, cracked, consisting of small circular patches 2–3 lines across, often becoming confluent and forming irregular patches. In barren specimens the surface is often coated with particles of lime, giving it a scurfy appearance.

CORTICIUM MYXOSPORUM, *P. Karst.* Primitus subrotundum, dein effusum, contextu floccoso, submembranaceum, aridum, adhærens, dein facile integrum secedens, ambitu furfuraceo-floccosum, contiguum, hinc inde minute papillosum, lacteum, fere absque hymenio distincto, subtus glabrum; sporis oblongatis, vulgo curvatis, mucosis, eguttulatis, albis, $8–9 \times 3–4$ μ (muco excepto). —*P. Karst. Symb. Myc. Fenn.* ix. p. 53.

On bark of *Pinus sylvestris*. Finland.

Resembling *Odontia papillosa* and *O. crustosa*.

CORTICIUM POLYPORIDEUM, *Berk. & Curt.* Subiculo tomentoso candido marginem angustum formante; hymenio pulverulento, pallide alutaceo; sporæ subtiliter verruculosæ, ellipsoideæ, $10 \times 5–6$ μ.—*Berk. & Curt. in Grev.* i. p. 177. (Type in Herb. Berk. n. 3966.)

On wood. Alabama.

"Effused, irregular; subiculum white, well developed, tomentose, projecting beyond the pale tan-coloured pulverulent hymenium, and forming a narrow border. Allied to *C. Dregeanum*, Mont. & Berk." (*Berkeley.*)

Broadly effused, thin; subiculum white; margin byssoid; hymenium ochraceous, minutely porous, cracking and breaking away in patches from the subiculum.

CORTICIUM DECOLORANS, *P. Karst.* Effusum, arcte adnatum vel adglutinatum, glabrum, ambitu fibrillis albis fimbriatum; hymenio ceraceo, ex albo flavido, sæpe in lividum vel alutaceum vergente, sicco rubescente livido pruinaque sat densa testacea vel cana consperso, contiguo, levi; sporis ellipsoideis, 4–5 × 2–3 μ.—*P. Karst. Symb. Myc. Fenn.* ix. p. 53.

On dead wood of pine, alder, or willow. Finland.

Resembling *Corticium radiosum* and *C. lividum*, but distinguished by the densely pruinose hymenium.

CORTICIUM DEBILE, *Berk. & Curt. in herb.* Late effusum, tenuissimum, subsecernibile, contextu margineque byssoideo albis; hymenio glabro, ochraceo; sporæ ellipsoideæ, 7 × 3–4 μ. (Type in Herb. Berk. n. 4065.)

On wood. Venezuela; United States.

Broadly effused, thin; substance breaking up and peeling off in patches.

CORTICIUM FARINELLUM, *P. Karst.* Late effusum, indeterminatum, farinulentum, arcte adnatum, tenuissimum, ambitu primitus subbyssinum; argillaceo-album, hymenio farinaceo, glabro, sicco rimoso, albo; sporis minimis.—Xerocarpus farinellum, *P. Karst. Symb. Myc. Fenn.* ix. p. 52.

On bark of *Abies excelsa*. Finland.

Very similar to *Corticium calceum*, but readily distinguished by its farinaceous substance.

CORTICIUM FŒTIDUM, *Berk. & Broome.* (Pl. VI. f. 3.) Olidum, effusum, resupinatum, subtus arachnoideum, ex albo ochraceum, glabrum; sporæ ellipsoideæ, 7 × 4 μ.—*Berk. & Broome in Ann. Nat. Hist.* ser. 5, iii. 1879, p. 211. (Type in Herb. Berk. Kew. n. 4029.)

On sawdust. Coed Coch, Wales.

Not apparently a form of *Thelephora fastidiosa.* (*Berk. & Broome.*)

Forming a thin adnate crust on sawdust. Hymenium pallid when dry, even or rather rugged from inequalities of the matrix.

CORTICIUM HYPOPYRRHINUM, *Berk. & Curt.* Subiculo pyrrhino marginem hic illic tenuissimum formante; hymenio albido;

sporæ ellipsoideæ, 10×4–$5\ \mu$.—*Berk. & Curt. in Grev.* i. p. 179. (Type in Herb. Berk. n. 4061.)

On wood, apparently vine. Carolina.

"Subiculum extremely thin, rufous sometimes; hymenium dirty white, pulverulent." (*Berkeley.*)

Consisting of very thin scattered patches; hymenium minutely fibrillose or spongy.

Corticium lacteum, *Fr.* Late effusum, submembranaceum, lacteum, subtus et ambitu laxe fibrillosum; hymenio ceraceo, siccitate rimoso-partito, pallide ochraceo; sporæ subglobosæ, 5–6 μ diam.—*Fr. Hym. Eur.* 649; *Berk. Outl.* 273; *Wint. Kr. Fl.* 337; *P. Karst. Myc. Fenn.* 312; *Stevens. Brit. Fung.* 274; *Cooke, Handb.* p. 321.—Thelephora lactea, *Fr. Syst. Myc.* i. p. 452. Thelephora cariosa, *Pers. Myc. Eur.* i. p. 151. Hypochnus, *Bon. Handb.* f. 259. (Specimen from Fries in Herb. Berk. 3973.)—*Exs.*: P. Karst. Fung. Fenn. 623; Sacc. Myc. Ven. 797, 798; Roum. Fung. Gall. 2210; Berk. Brit. Fung. 250; Thuem. Fung. Aust. 922.

On wood. Britain; Europe.

Broadly effused and usually broken up; whitish, ochraceous, or buff when dry, thin; margin indeterminate, fibrillose, often radiating in long thick mycelial strands in a frondose manner for several inches; hymenium when perfect smooth, cracked, showing the fibrillose substratum. Differs from *C. radiatum* in the cracked hymenium, and from *C. radians* in the subglobose spores. Often barren.

Corticium levissimum, *Massee.* Longitudinaliter effusum, tenuissimum, adglutinatum, levissimum, contiguum, aridum, glabrum, subtus obsolete flocculosum, ochraceo-pallescens vel alutaceum; sporis.........ignotis.—Xerocarpus levissimum, *P. Karst. Symb. Myc.* xii. p. 111.

On woody birch. Lapland.

Superficially resembling *Corticium calceum.*

Corticium calotrichum, *P. Karst.* Effusum, immarginatum, adnatum, subtus adpresse fibrillosum ambituque subbyssinum, demum membranaceum, subsecedens et glabrescens; mycelio ex hyphis ramosis, articulatis, obtusis, albis, 6–12 mm. crassis contexto; hymenio tenui, ceraceo, levi, contiguo, rarius siccitate rimoso, albido, mox in flavum vel luteum vergente; cystidiis

nullis; sporis sphæroideis, 6–9 μ diam.—*P. Karst. in Rev. Myc.* 1888, p. 73.

On old bark of *Alnus incana*. Finland.

Allied to *Corticium radiosum*.

Corticium convolvens, *P. Karst.* Elongato-effusum, ceraceo-gelatinosum, subtus fibrillosum vel subfloccosum, determinatum, adglutinatum, ambitu similari, pallidum; hymenio contiguo, papillis dispersis, subhemisphæricis, subæqualibus, mediis, sicco hinc inde late rimoso; sporis ovoideo-sphæroideis, $3–5 \times 2–4\,\mu$.—*P. Karst. Symb. Myc. Fenn.* ix. p. 54.

On soft decaying beech-wood. Finland.

Corticium confluens, *Fr.* Adglutinatum, submembranaceum, ambitu radiato (non fibrilloso); hymenio lævi, nudo, hyalino, sicco candicante; sporæ cylindraceo-ellipsoideæ, $20 \times 10\,\mu$.—*Fr. Hym. Eur.* p. 655; *Berk. Outl.* 276; *Cooke, Handb.* p. 325; *Stevens. Brit. Fung.* p. 279; *Wint. Krypt. Fl.* p. 332.—Thelephora epidermea, *Pers. Myc. Eur.* i. p. 136.

On bark, usually beech. Britain; Europe.

Sometimes originating as isolated rounded patches, which soon become confluent; closely adnate, thin.

Corticium Berkeleyi, *Cooke.* Latissime effusum, tenuissimum, indeterminatum, matrici totum adnatum; hymenio rimoso, sordide albo vel fuscescenti; sporæ ellipsoideæ, $7–8 \times 4\,\mu$.—*Exs.*: Rav. Fung. Amer. Exs. n. 225; Ellis, N. Amer. Fung. 934.

On pine-bark. Southern United States.

Very thin, indeterminate, broadly effused, cracked; hymenium white or brownish. Superficially resembling *C. vagum*, but readily distinguished by the spores.

Corticium byssinum, *P. Karst.* Niveum, irregulariter effusum, byssinum, laxe adhærens, mollissimum, subtus araneoso-byssinum, ambitu araneosum sporisque pulverulentum; hymenio membranaceo, tenuissimo, fragilissimo, contiguo, lævi; sporis sphæroideis, 2–3 μ diam., levibus.—*P. Karst.* (*as* Lyomyces), *in Fung. Rar. Fenn. et Sibir.* p. 137.

Hyphæ septate, branched, 3 μ thick.

Corticium cremicolor, *Berk. & Curt.* *C.* mycelio albo innato; hymenio immarginato rimoso areolato, sicco pallide brunneo; sporæ subglobosæ, $8–8 \times 9\,\mu$.—*Berk. & Curt. in Grev.* i. p. 180. (Type in Herb. Berk. n. 4062.)

On holly. Alabama.

Mycelium white, minute; hymenium cream-coloured when fresh, soon cracked into longish areolæ, here and there papillose. (*Berkeley.*)

Hymenium pale brown or reddish, cracked and showing a whitish fibrous substratum.

Corticium colliculosum, *Berk. & Curt.* Arcte adnatum; mycelio spongioso, albo; hymenio læte ochroleuco papillato granulatoque glabro, rimoso; sporæ oblongo-ellipsoideæ, $10 \times 5\ \mu$.—*Berk. & Curt. in Grev.* ii. p. 3. (Type in Herb. Berk. 4016.)—*Exs.*: Ellis, N. Amer. Fung. 329; Ellis, New Jersey Fung. 3498; Thuem. Myc. Univ. 605.

On wood. United States.

Thin, adnate, inseparable from the matrix, springing from a white mycelium which penetrates the matrix, but is scarcely visible externally; hymenium papillate, and also minutely granulated, independently of the matrix. (*Berkeley.*)

Effused, adnate, often thick, margin becoming thin and indeterminate; hymenium waxy, pale or bright ochre, rugulose or papillate, cracked.

Corticium alopecinum, *Berk. & Broome.* Late effusum, cervinum, secernibile, membranaceum; contextu molli fibroso fulvo; hymenio in statu perfecto ceraceo, ochraceo; sporæ oblongo-ellipsoideæ, 10×6–$7\ \mu$.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 70. (Type in Herb. Berk. n. 4073.)

On dead wood. Ceylon.

Broadly effused, separable, resembling thin felt, margin often indeterminate; hymenium ochraceous, generally pulverulent as described by Berkeley, but some of the type-specimens show that in the fully-developed condition it is waxy.

Corticium alliaceum, *Quelet.* Adnatum, membranaceum, 2–3 cm. diam., farinaceo-arachnoideum, candidum, niveum; hymenio undulato, pubescenti-pruinoso, dein rimoso, odorem alliaceum evanidum præbente; sporis ellipsoideo-oblongis, $15\ \mu$ longis, allantoideis, 2–3 guttulatis, hyalinus.—*Quelet, Quelq. espec.* ii. p. 8.

On bark. Lorraine and Jura, France.

Var. aceris; tenue, versiforme, plerumque angulosum, raro singulis individuis fere 3 cm. latis, e cretaceo-albidum, papillosum, tandem sporis pulveraceum.—*Schulzer, in Hedw.* 1885, p. 148.

On living bark of *Acer.* Slavonia.

CORTICIUM AMBIENS, *Berk. & Broome.* Late effusum, contextu niveo; hymenio candido, glaberrimo; margine tenuissimo, agglutinato; sporæ ellipsoideæ, 5–6 × 3 μ.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 72. (Type in Herb. Berk. n. 3977.)

On dead branches. Ceylon.

"Spreading for several inches, extremely smooth, scarcely at all cracked; substance rather rigid, moderately thick, white; margin, when present, consisting of very delicate threads glued to the matrix." (*Berk. & Broome, l. c.*)

Pure white or with a slight tinge of ochre or pink, rather thick, compact; margin adnate, often indeterminate and pulverulent; hymenium very smooth like polished ivory, even, often minutely cracked when dry.

CORTICIUM AUBERIANUM, *Mont.* Adnatum, primum orbiculare, totum floccoso-farinaceum, niveum, tandem tenuissime submembranaceum, longitrorsum confluenti-effusum; ambitu persistente floccoso; hymenio albido, mox in luteum vel griseum vergente; sporæ ellipsoideæ, 6 × 4 μ.—*Mont. Crypt. Cuba*, p. 372. (Specimen from Montagne from Cuba in Herb. Berk. n. 4079.) —*Exs.*: Husnot, Pl. des Antilles, 602.

On branches, &c. Cuba; United States; Patagonia; Victoria, Australia; New Zealand.

Montagne says, "hymenio pallescente setulis umbrinis pubescente;" but in his own specimen I can detect no trace of setæ, and in every other respect it agrees with the description given.

Thin, broadly effused, margin almost indeterminate, whitish, byssoid or radiato-fibrillose; from white to pale ochre, sometimes with tints of yellow or purplish grey.

CORTICIUM ARCHERI, *Berk.* Resupinatum, rufo-pallidum, intus album, crassiusculum, rimosum, immarginatum; sporæ cylindraceo-ellipsoideæ, 7–8 × 3 μ.—*Berk. in Hook. f. Flora Tasm.* ii. p. 260. (Type in Herb. Berk. n. 4051.)

On charred wood. Tasmania.

Effused, rather thick, immarginate; hymenium cracked into squares, substance white, very compact, not fibrillose.

CORTICIUM ARACHNOIDEUM, *Berk.* Tenue, effusum, pallidum, immarginatum, subtus fibrillosum vel subfloccosum, ambitu fibrillis albis fimbriatum; hymenio ceraceo, contiguo, sicco hinc inde rimoso; sporæ globosæ, 6–7 μ diameter.—*Berk. in Ann.*

Nat. Hist. xiii. (1844) p. 345; *Outl.* 273; *Fr. Hym. Eur.* 649; *Cooke, Handb.* n. 924. (Type in Herb. Berk. 3974.) *Exs.*: Thuem. Myc. Univ. 908; Ellis, N. Amer. Fung. 411. (Ellis, N. Amer. Fung. 3137 and 3455, called *C. arachnoideum*, are hypochnoid forms of some other species than the present.)

On wood, bark, and running over mosses &c. Britain; Europe; Socotra; United States; Venezuela; Victoria, Australia; Tasmania; Bombay.

Forming delicate effused, arachnoid patches of a snowy white; threads by no means forming fibres, but spreading like a delicate web and often remaining barren; but under favourable circumstances giving rise to a smooth hymenium, consisting of elliptic sporophores arranged in little bunches. Its habit is not unlike that of *Thelephora bombycina*, Berk.

The specimens on which Berkeley founded the species were in the hypochnoid condition, but afterwards numerous well-developed specimens were met with, which are with the type in Herb. Berk. Kew. The hymenium is continuous in many instances for several inches, pale ochraceous (when dry) or often with a very pale tinge of glaucous green, slightly cracked; margin shading off into radiating mycelium, cobweb-like or farinose; frequently when growing in damp, dark places, as the underside of logs, or between the loose bark and the wood, the whole plant remains arachnoid with basidia in scattered tufts, and not forming a continuous hymenium.

CORTICIUM SCIRPINUM, *Wint.* Longitudinaliter extensum, membranaceum, tenue, primo plus minus orbiculare, demum irregulare, album, senectute flavidum, vix floccosum, calvum, ambitu subconformi.—*Wint. Krypt. Fl.* p. 340.—*Exs.*: Thuem. Myc. Univ. 1505, as *Athelia scirpina*.

On dead leaves of *Scirpus silvaticus*. Germany.

CORTICIUM TESSULATUM, *Cooke.* Effusum, membranaceum, molle, candidum, subtus ambituque laxe albo-fibrillosum; hymenio lævi, glabro, pallide ochraceo, siccitate tessellato-partito; sporæ ellipsoideæ, 6–7 × 3–4 μ.—*Cooke in Grev.* vi. p. 132. (Type in Herb. Kew.)—*Exs.*: Rav. Fung. Amer. 127.

On pine-bark. S. Carolina.

When the hymenium is fissured, the byssoid snow-white threads of the mycelium may be seen running over the matrix. (*Cooke.*)

Thin, irregularly effused, indeterminate, subiculum silky. When dry, the hymenium is sometimes bright ochre with slight tinge of orange.

Corticium Typhæ, *Fuckel.* Longitudinaliter effusum, tenue, primo maculæforme, album et byssinum, omnino glabrum, dein subfarinaceum, alutaceum; sporæ ellipsoideæ, 6×3–$4\ \mu$.—*Fuckel, Symb.* p. 27; *Fr. Hym. Eur.* 657; *Stevens. Brit. Fung.* 281; *Wint. Krypt. Fl.* p. 339.—Athelia typhæ, *Pers. Myc. Eur.* i. p. 84. (From specimen marked "*Athelia Typhæ*, Pers., in foliis *Typhæ latifoliæ*," in Herb. Berk. n. 4026.)—*Exs.*: Desm. Cr. Fr. n. 1811.

On dried leaves of *Typha* and *Carex*. Britain; Europe.

Very thin; hymenium, when perfect, smooth, minutely pulverulent, and sometimes very minutely cracked; margin sometimes indeterminate and farinose.

Corticium vellereum, *Ellis & Cragin.* Sordide album, contextu laxo, floccoso; ambitu byssoideo; sporæ copiosæ, globosæ, 4–5 μ diam.—*Ellis & Cragin in Journ. Myc.* i. p. 58.

On trunks. United States.

Corticium sambuci, *Fr.* Late effusum, subinnatum, incrustans, ambiens, indeterminatum, album, vegetum contiguum, siccum flocculoso-collabens; sporæ ellipsoideæ, 8–10×5–$6\ \mu$.—*Fr. Hym. Eur.* 660; *Berk. Outl.* 276; *Grev. Scot. Cr. Fl.* t. 242; *Stevens. Brit. Fung.* 283; *Cooke, Handb.* p. 325; *Wint. Krypt. Fl.* p. 328.—*Exs.*: Cooke, Fung. Brit. 413; ed. 2, 408; Rav. Fung. Amer. 722; Thuem. Fung. Austr. 328; Sydow, Myc. March. 102; Roum. Fung. Gall. 2495 and 2911; Desm. Cr. Fr. 320; Westendorp, Cr. Belg. 588.

Britain; Europe; N. America.

Forming broadly effused indeterminate white patches on *Sambucus.*

Corticium alutarium, *Berk. & Curt.* Effusum, emarginatum, alutaceum v. ochraceum; subiculo filamentoso; hymenio papilloso; sporæ subglobosæ, $6 \times 5\ \mu$.—*Berk. & Curt. in Grev.* ii. p. 4. (Type in Herb. Berk. n. 4072.)—*Exs.*: Ellis, N. Amer. Fung. 517.

United States.

Either on smooth or rugged bark on wood, following all the inequalities; bright, tan-coloured, papillate. (*Berkeley.*)

Thin, broadly effused, indeterminate, mycelium very much branched, hyphæ thin.

Corticium interruptum, *Berk.* Tenue, secernibile, ochroleucum, primitus sericeum, subtus sericeo-tomentosum, album; hymenio hic illic interrupte ceraceo; sporæ subglobosæ, 8×7 μ. —*Berk. Fung. Glaziou*, n. 752. (Type in Herb. Berk. Kew. n. 4068.)

On wood. Rio Janeiro.

Very thin, effused, separable, originating in distinct patches, which often become confluent, ochraceous olive when dry.

Corticium lactescens, *Berk.* Ceraceo-molle, adglutinatum, undulatum, carneum, lactescens, margine byssoideo, contiguo, brevi, hymenio demum rimoso; interstitiis pallidis, sericeis; sporæ globosæ, 4 μ diam.—*Berk. Outl.* p. 274; *Fr. Hym. Eur.* 650.—Thelephora salicina, *Pers. Myc. Eur.* i. p. 133.—*Exs.*: Rav. N. Amer. Fung. 271. (Type in Herb. Berk. 3982.)

On oak, willow, &c. Britain; U. States.

Broadly effused, closely adnate, rather thick, generally very much cracked during drying. Hymenium smooth, polished, ochraceous, or sometimes passing to a lurid red. Margin rather thin, sterile, not cracked. When broken exuding a whitish watery milk.

Corticium lacunosum, *Berk. & Broome.* Late effusum, molle, mycelio lanosum fuscum, lacunosum; hymenio ochraceo vel cinnamomeo, ceraceo, contiguo; sporæ ellipsoideæ, hyalinæ, 7×4–5 μ.—*Berk. & Broome, in Ann. & Mag. Nat. Hist.* ser. 4, xi. p. 343; *Fr. Hym. Eur.* p. 661. (Type in Herb. Berk. Kew. no. 4023.)

On wood. England; Scotland.

Broadly and irregularly effused, generally loosely fibrillose and spongy, with various-sized lacunæ on the surface; vaguely spreading on the surface of wood and passing on to surrounding bodies and the ground, sometimes forming a thick felt with scattered tufts of sporophores as in the imperfect forms of *Corticium arachnoideum*; and in one specimen in Herb. Berk. passing from the condition described above into a compact, continuous waxy hymenium of an ochraceous or pale cinnamon-colour when dry. The hyphæ are thick, 4–5 μ, and furnished with numerous clamp-connections. Related in habit to *Corticium porosum*, differs in the hymenium not being cracked when dry.

Corticium nitidulum, *P. Karst.* Elongato-effusum, adglutinatum, ceraceum, glaberrimum, luridum vel argillaceo-lutescens,

ambitu similari; hymenio lævi, glabro, contiguo, sicco nitente; sporis circ. 2–3 × 1 μ.—*P. Karst. Symb. Myc. Fenn.* p. 11.

On branches of *Salix capræa.* Finland.

Differs from *Corticium calceum* in the hymenium not being cracked when dry.

Corticium polygonioides, *P. Karst.* Orbiculare, dein confluens, ambiens, induratum, subgrumosum, adnatum, demum recedens, album vel testaceo-albidum, ambitu similari; hymenium leve, pruina densa, violascente vel rosello-albida, demum albida conspersum, siccum rimosum; sporis ovoideis, minutissimis.—*P. Karst. Symb. Myc. Fenn.* viii. p. 12.

On bark and wood of *Salix capræa.* Finland.

Readily distinguished from *Corticium polygonium* by the minute spores.

Corticium radiosum, *Fr.* Subrotundum, membranaceum, adnatum, subtus adpresse fibrillosum, ambitu fibrillis albis fimbriatum; hymenio lævi, glabro, alutaceo, contiguo; sporæ subglobosæ, 5–6 μ diam.—*Fr. Hym. Eur.* 649; *P. Karst. Myc. Fenn.* 312; *Wint. Krypt. Fl.* 337; *Fr. Icon.* 198.—Thelephora alutacea, *Schrad. Spic.* p. 187. Athelia ochracea, *Pers. Myc. Eur.* i. p. 84. —*Exs.*: Roum. Fung. Sel. Gal. 204; Fuckel, Fung. Rhen. 2506; Klotzsch, Herb. Myc. 414; Roum. Fung. Gall. 2513; Thuem. Myc. Univ. 2013; P. Karst. Fung. Fenn. 919 & 624.

On rotten wood. Scotland; Europe; Venezuela.

Resembling in habit *C. lacteum*, but distinguished by the dark ochraceous hymenium, which does not crack when dry.

Corticium siparium, *Berk. & Curt.* Subiculum spongiosum tomentosum pallidum, hymenio ochraceo demum fuscescente, ambitu fibrilloso ochraceo; sporæ ellipsoideæ, 6 × 4 μ.—*Berk. & Curt. in Grev.* i. p. 177. (Type in Herb. Berk. n. 3958.)

On *Liquidambar.* Alabama.

"Subiculum consisting of spongy, pallid down; edge slightly turned up; hymenium at first ochraceous, gradually acquiring a brownish tint." (*Berkeley.*)

Margin often broadly fibrillose, ochraceous; hymenium ceraceo-cartilaginous, bay, entire or much cracked.

Corticium subalutaceum, *P. Karst.* Longe lateque effusum, adnatum, immarginatum, contiguum, floccoso-furfuraceum, tenue,

obscurius; sporis elongatis, curvatis, 5–6 × 1.—*P. Karst. Symb. Myc. Fenn.* x. p. 65.

On decayed pine. Finland.

Related to *Corticium sordidum*, but distinguished by the thicker subiculum, the thin continuous hymenium, and long narrow spores.

Corticium sordidum, *P. Karst.* Longitudinaliter effusum, adglutinatum, immarginatum, ceraceum, subtus leviter floccosum, leve, siccitate rimose partitum, sordide albidum, siccum sordide fuscescenti-flavescens, ambitu flocculoso-furfuraceum; sporis ellipsoideis vel oblongatis, 4–5 × 2–3.—*Karst. Symb. Myc. Fenn.* x. p. 65.

On rotten branches of *Pinus sylvestris*. Finland.

Very rare. At first sight passing for *Corticium calceum*, but quite distinct.

** *Hymenio læte colorato.*

Corticium cinnabarinum, *Massee*, n. sp. Late effusum, adglutinatum, immarginatum; hymenio contiguo, lævi, ceraceo, cinnabarino; sporæ subglobosæ, 5–6 μ. diam. (Type in Herb. Kew.)

On wood. Clarence River, Australia.

Spreading for several inches, rather thin, immarginate, sometimes subdeterminate, byssoid and pale.

Corticium roseolum, *Massee*, n. sp. (Pl. VI. f. 2.) Latissime effusum, indeterminatum, tenuissimum; hymenio contiguo, glabro, e pulchre roseo pallescente; sporæ subglobosæ, basi apiculatæ, 7 × 8–9 μ. (Type in Herb. Berk. n. 3995 *a.*)

On old worked wood. Britain.

Spreading irregularly for many inches on smooth wood, exceedingly thin, adglutinated; margin indeterminate; hymenium continuous when dry, at first of a beautiful bright rose-colour, becoming paler and persisting as pale ochraceous with only a tinge of rose. Spores very large, abundant. Resembling in habit *Peniophora incarnata* (= *Corticium incarnatum*), but the latter is a true *Peniophora*, and the spores are also very different. In colour resembling *Peniophora rosea* (= *Corticium roseum*), which is also a *Peniophora*, much thicker in substance, with a determinate, delicate whitish, byssoid margin, and sausage-shaped spores.

Corticium miniatum, *Cooke.* Effusum, adnatum, miniatum, ambitu fimbriato albicante; hymenio subpulverulento, fatiscente,

subtus umbrino; sporæ globosæ, hyalinæ, 5–6 μ diam.—*Cooke in Grev.* ix. p. 2. (Type in Herb. Kew.)

On bark. Queensland.

When dry the hymenium resembles patches of dried blood, which cracks off and exposes the umber substratum. (*Cooke.*)

Broadly effused, rigid when dry, hymenium continuous or minutely cracked. Red colouring-matter is soluble in weak alkaline solution, and stains the spores.

CORTICIUM CINCTULUM, *Quelet.* Membranaceum, adhærens, orbiculare, 2–3 mm. diam., tenue, pruinosum, brunneum; margine angulato, pubescenti, albo; sporis ellipsoideo-oblongis, 8 μ long., hyalinis.—*Quelet, in Assoc. Fr.* 1882, p. 15.

On bark. France.

CORTICIUM CAULIUM, *Berk. & Curt.* Effusum, incrustans, leve, cinnabarinum, intus luteum; sporæ ellipsoideæ, 9×4–5 μ.—*Berk. & Curt. in Journ. Acad. Nat. Sc.* vol. ii. 1853, p. 279.—Thelephora caulina, *Schweinitz, MS.* (on specimen in Herb. Berk. n. 4084).

On dead herbaceous stems. Surinam.

Like red sealing-wax, often entirely surrounding thin stems, firm, shining, bright vermilion or with purple tinge.

CORTICIUM CARNEUM, *Berk. & Cooke.* Effusum, membranaceum, ochraceo-carneum, ambitu albo-fibrillosum; hymenio tenui, subcarneo, glabro, lævi, siccitate rimoso.—*Berk. & Cooke in Grev.* vii. p. 1.

On *Pinus contorta.* California.

CORTICIUM AURORA, *Berk.* Effusum, tenuissimum, adglutinatum, roseum, expallens, ambitu indeterminato; sporæ ellipsoideæ, basi apiculatæ, 10–11×7–8 μ.—*Berk. Outl.* p. 276; *Fr. Hym. Eur.* 657; *Cooke, Handb.* i. 326; *Stevens. Brit. Fung.* p. 281.

On dead leaves of *Carex.* Britain.

Very thin, effused, pink, becoming whitish. Distinguished from *Corticium Typhæ* by the large subpyriform or pip-shaped spores.

CORTICIUM ANTHOCHROUM, *Fr.* Late effusum, membranaceum, lateritio-roseum, expallens, ambitu byssino, pallidiore; sporæ ellipsoideæ, 11–13×8–9 μ.—*Fr. Hym. Eur.* 661; *Stevens. Brit. Fung.* 284; *Wint. Krypt. Fl.* 327.—Thelephora anthochroa, *Pers. Syn.* 576 (specimen from Fries in Herb. Berk. n. 4024).—*Exs.*: Fuckel, Fung. Rhen. 2612.

On bark. Britain; N. Europe.

Effused, adnate, thin, margin rather vague; hymenium brick-red, with rosy tinge or brownish red, becoming paler and more ochraceous; hymenium when perfect waxy, but usually sterile and minutely velvety under a lens, sometimes cracked.

CORTICIUM ALBIDO-CARNEUM, *Massee*. Late effusum, adglutinatum, tenuissimum, ambitu albo subradiante; hymenio lilacino, pruina alba consperso, sicco rimoso; sporæ ellipsoideæ, 7×4 μ.—Thelephora albo-carnea, *Schwein. Syn. N. Amer. Fung.* n. 717. (Specimen from Schweinitz in Herb. Berk.)

On bark of *Vitis*. United States.

Very thin, closely adnate, margin pale, in parts indeterminate; hymenium dirty lilac or bright grey when dry, much cracked. Resembles thin forms of *C. scutellare*, but distinguished by the spores and the pruinose hymenium.

CORTICIUM EFFUSCATUM, *Cooke & Ellis*. Effusum, incrustans, aureo-fulvum, absque pellicula, ambitu concolore; hymenio pulverulento, fragili, fatiscente, fuscescente; sporis profusis, globosis, lævibus, hyalinis, 7–9 μ diam.—*Cooke & Ellis in Grev.* ix. p. 103. (Type in Herb. Kew.)—*Exs.*: Ellis, N. Amer. Fung. 1208.

On rotten log. New Jersey, U.S.

Its only near ally is *Corticium pactolinum*, C. & H. These agree in the fragile pulverulent hymenium and profuse globose spores. (*Cooke*.)

Thin, effused, often indeterminate, circumference byssoid. Hymenium often pulverulent, but when perfect waxy; dirty pallid ochre when day. *Corticium pactolinum* has coloured spores, and has been referred to the genus *Chromosporium*.

CORTICIUM FLAMMANS, *Fr.* C. mycelio puniceo hymenio glabro, fusco-purpureo.—*Fr. Summ. Veg. Scand.* p. 334; *Fr. Hym. Eur.* p. 657.

Very little is known respecting this species, which has, so far as is known, only been seen by Fries in Scandinavia.

CORTICIUM GLABRUM, *Berk. & Curt.* Late effusum; subiculo radiante byssoideo cito evanido lateritio; hymenio glabro, rimoso concolore; sporæ ellipsoideæ, 6–7 × 3–4 μ.—*Berk. & Curt. in Grev.* i. p. 178. (Type in Herb. Berk. Kew. n. 4036.)—*Exs.*: Ellis, N. Amer. Fung. n. 716.

On bark. Carolina.

"Subiculum where well developed radiating and byssoid, but soon vanishing; hymenium brick-red, smooth, not velvety, as in *C. velutinum*." (*Berkeley*.)

Thin, broadly effused, margin often irregular; hymenium reddish ochre, pale ochre, or brick-red, cracked; substratum fibrillose.

Corticium Kalchbrenneri, *Massee*. Effusum, tenue, membranaceum, adnatum, subtus margineque arachnoideo-byssinum, floccis laxis albis; hymenio ceraceo, molli, glabro, explanato, miniato, siccitate pallescente, carneo, subtiliter pruinoso.—Corticium miniatum, *Kalchbrenner*, *Szep. Gomb.* p. 229.

On trunks and wood. Hungary.

Kalchbrenner's specific name was antedated by Cooke.

Corticium Leprieurii, *Mont.* Spongioso-submembranaceum, effusum, adglutinatum; hymenio cinnamomeo-umbrino, glabro, nitido, ambitu nudo.—*Montagne*, *Guyan.* n. 417.

On living bark. Cayenne.

Corticium lilacino-fuscum, *Berk. & Curt.* Effusum; margine angusto albo, byssoideo; hymenio lilacino fusco hic illic ochraceo tingente, demum rimoso; sporæ ellipsoideæ, 10 × 5–6 μ.—*Berk. & Curt. in Grev.* i. p. 180. (Type in Herb. Berk. n. 4067.)—*Exs.*: Ellis, N. Amer. Fung. 515.

On smooth wood, over which it forms a thin stratum, with a narrow white border arising from the subiculum; hymenium lilac, tinged with brown, at first even and paler, then cracked, showing the white subiculum. (*Berkeley*.)

On wood. United States.

Very thin, effused, closely adnate, margin determinate, radiato-byssoid; hymenium waxy, cracked, ochraceous-lilac. Distinct from *C. subrepandum*, Berk. & Cooke, and *C. pauperculum*, Berk. & Curt.

Corticium molle, *Fr.* Subrotundum, flocooso-carnosum, laxe contextum, molle, pallidum, rubello-maculatum, subtus villosum; ambitu nudo; hymenio ceraceo, papilloso, sicco rimoso; sporæ cylindraceo-ellipsoideæ, utrinque obtusæ, 7 × 5 μ.—*Fr. Hym. Eur.* p. 660.—Thelephora molle, *Fr. Syst. Myc.* i. p. 443.

On wood and bark of pine. Britain; Europe.

Corticium Marchaudii, *Pat.* Effusum, tenuissimum, granuloso-tuberculosum, roseum; sporis ovoideis, hyalinis, 6 × 3 μ.—

Patouillard, Tab. Analyt. p. 16, n. 25; *Le Breton, Champ. Norm.* p. 6.

On bramble-twigs. France.

A conidia-bearing state is described, presenting the general features of the basidia-bearing plants. The conidia are borne singly on large cells of variable form, sometimes clavate with the apex blunt and rounded, in others attenuated into a long pedicel-like prolongation supporting the conidium. Basidia, which are furnished with four long arcuate sterigmata, are very rare on the conidia-bearing plants.

CORTICIUM MARTIANUM, *Berk. & Curt.* Subiculum tenuissimum, fulvum; hymenio, croceo; sporæ ellipsoideæ, basi apiculatæ, $3 \times 2\ \mu$.—*Berk. & Curt. in Grev.* i. p. 179. (Type in Herb. Berk. Kew. n. 4040.)—*Exs.*: Rav. Fung. Car. 30.

On rough wood. Boston, U.S.

"Forming little detached patches, very irregular in form; subiculum very thin, tawny, covered here and there with the saffron-yellow hymenium. Allied to *C. peroxydatum*, Berk. & Broome, a Ceylon species." (*Berkeley.*)

CORTICIUM OCHTHODES, *Berk. & Curt.* Effusum, resupinatum, umbrino-fulvum, margine arcuato subtomentoso; hymenio colliculoso.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 336.

On dead wood. Cuba.

"This is anomalous. Young specimens have the hymenium nearly even; in age it becomes rough, and sometimes the papillæ are elongated. *Thelephora puteana*, however, shows us how a species with a normally even hymenium may become covered with cribriform processes."

CORTICIUM POLYGONIUM, *Fr.* Adnatum, limitatum, mox induratum, subgrumosum, incarnatum, ambitu similari; hymenio sub pruina densa rubro; sporæ cylindraceo-ellipsoideæ, 14–16 $\times$ 5–7 μ.—*Fr. Hym. Eur.* p. 655; *Berk. Outl.* p. 276; *Cooke, Handb.* p. 941; *Stevens. Brit. Fung.* p. 280; *Wint. Krypt. Fl.* p. 332; *P. Karst. Myc. Fenn.* p. 316. (Specimen from Fries in Herb. Berk. Kew. n. 4203.)—*Exs.*: Cooke, Fung. Brit. 412, ed. 2, 6; Roum. Fung. Gall. 2010; Sacc. Myc. Ven. 1111 & 407; Fuckel, Fung. Rhen. 1312; Thuem. Fung. Austr. 822; Desm. Cr. Fr. ser. i. 878.

On bark, more especially poplar; also on wood, Britain; Europe; U. States; New Zealand.

Appearing under the form of distinct *Tubercularia*-like pustules, which usually become confluent, thick, and again separating more or less when dry, giving the mass a much cracked appearance, sometimes continuous, then tuberculose; margin thin, adnate, byssoid; hymenium pruinose, pinkish, lilac, or dirty ochraceous.

CORTICIUM PETERSII, *Berk. & Curt.* Subiculum tenue, tomentosum, pallidum hic illic in fibrillas compactum; hymenio rimoso, alutaceo hic illic lateritio; sporæ oblongo-ellipsoideæ, 12–14 × 5–6 μ.—*Berk. & Curt. in Grev.* i. p. 177. (Type in Herb. Berk. n. 4071.)—*Exs*: Rav. Fung. Car. 28; Rav. Fung. Amer. 703; Ellis & Everh. N. Amer. Fung. ser. ii. 1716.

On wood, bark, and on the ground. United States.

"Subiculum thin, pallid, tomentose; here and there forming creeping fibres; hymenium pale, tan-coloured, in parts tinged with brick-red." (*Berkeley.*)

Thin, effused, and with a tendency to break away from the substratum.

CORTICIUM ROSELLUM, *Speg.* Effusum, tenue, cartilagineo-carnosulum, versiforme, sæpius orbiculare, lobato-sinuatum, matrici tenaciter adhærens, ambitu perfecte determinatum, sed nunquam liberum; hymenio glabro, e matrice irregulariter plus minusve scrupuloso, pulchre roseo, margine determinato integro, zona tenui fusco-sericea ornato et minute albo-byssaceo appendiculato; sporis non visis.—*Speg. Fung. Argent.* Pug. iii. n. 25, p. 10

On bark of old orange-trees. Buenos Ayres.

Very variable in size, several often confluent; hymenium scarcely cracked when dry.

CORTICIUM RUBROPALLENS, *Massee.* Late effusum, tenue, ambitu albo subradiante; hymenio ochraceo-incarnato, sicco rimoso pallescente; sporæ cylindraceo-ellipsoideæ, 8–9 × 3 μ.—Thelephora rubropallens, *Schwein. Syn. N. Amer. Fung.* n. 677. (Specimen from Schweinitz in Herb. Berk.)

On bark. United States.

Broadly effused, thin; margin pale, byssoid or radiating, in parts almost indeterminate; hymenium, when dry, dirty ochraceous with tinge of rose, cracked.

CORTICIUM SUBTERRANEUM, *Rab.* Habitu *Hypheotrichis*, longe

lateque effusum, indeterminatum, subcrassum, ceraceum, lateritio-expallens, superficie bullato-tuberculosum, subtus et ambitu nudum; sporæ ellipsoideæ, $7 \times 4\ \mu$.—*Rabenh. in Fung. Eur.* n. 1006.

Saxony. Broadly effused on beams in subterranean places.

Corticium sanguineum, *Fr.* Late effusum, indeterminatum, laxe adhærens, subtus araneosum, sanguineum, ambitu laxe fibrilloso hymenioque lævi, glabro, incarnatis, demum pallidis; sporæ ellipsoideæ, $6 \times 4\ \mu$.—*Fr. Hym. Eur.* 650; *Berk. Outl.* 274; *P. Karst. Myc. Fenn.* 713; *Wint. Krypt. Fl.* 336; *Stevens. Fung. Brit.* 276; *Cooke, Handb.* i. 322. (Specimen from Fries in Herb. Kew.)—*Exs.*: Berk. Brit. Fung. 251; P. Karst. Fung. Fenn. 132; Fuckel, Fung. Rhen. 2507.

On wood. Britain; N. Europe; U. States.

Irregularly effused, adnate, thin; margin fibrillose or byssoid, running off into spreading strands of mycelium of a blood-red colour, mixed with thicker blackish-red radiating cord-like threads which penetrate and stain the wood red. Hymenium rarely red, generally pinkish or dirty ochraceous, slightly cracked when dry, usually barren and minutely fibrillose.

Corticium tremellinum, *Berk. & Rav.* Tremelloideum, albidum, siccum rufescens ambiens; hymenio glabro, nitido; sporæ ellipsoideæ, 10×5–$6\ \mu$.—*Berk. & Rav. in Grev.* i. p. 180. (Type in Herb. Berk. 3997.)

On the ground, running over whatever it meets with. Dirty white, gelatinous, tremelloid; rufous, hard and horny when dry." (*Berkeley.*)

Effused, irregular in form, dark reddish brown when dry, often covered more or less with particles of leaves, moss, &c., caught up in the gelatinous condition; hymenium smooth, polished.

On the ground and on bark. U. States.

Var. reticulatum; fuciforme, fasciculatum, reticulatum.

Imitating in form *Podisoma macropus*; forming erect fucoid tufts, reticulated below.

Corticium viticola, *Fr.* Effusum, confluens, adglutinatum, ambitu fibrilloso; hymenio læte aurantiaco vel rubro; sporæ ellipsoideæ, utrinque acuminatæ, $8 \times 5\ \mu$.—*Fries, Epicr.* 561.—Thelephora viticola, *Schwein. Car. Syn.* 1037; *Syn. N. Amer.*

Fung. 691. (Specimen from Schweinitz in Herb. Berk.)—*Exs.*: Rav. Fung. Car. 34.

On vine. United States.

Thin, effused; hymenium bright orange, sometimes red; margin byssoid or fibrous, sometimes brighter than the hymenium, sometimes paler, often vague.

Corticium venosum, *Berk. & Rav.* Late effusum; subiculo tomentoso; hymenio livido-pallido, e fibrillis subiculi parce et late reticulato.—*Berk. & Rav. in Grev.* i. p. 177; *Rav.* no. 1321.

Spreading widely; subiculum thin, tomentose, consisting of interwoven threads; hymenium livid but pale, marked here and there with wide reticulations, which appear to arise from the subiculum.

I have not been able to meet with any specimen bearing the above name, or answering to the description in the Berkeley Herbarium.

Corticium diaphanum, *Speg.* Latissime effusum, mucoso-membranaceum, pellucidum, tenuissimum, matrici laxe adhærens, margine subdeterminatum, non reflexum; hymenio vix evoluto, pulverulento-ceraceo, facillime detersili donatum, in sicco cartilagineum, sordide rufescenti-testaceum, irregulariter hinc inde contracto-fissum.—*Speg. Fung. Fueg.* p. 95.

On soft decayed beech-wood. Staten Island; Tierra del Fuego.

Closely related to *Corticium giganteum* (=*Peniophora gigantea*), but certainly distinct.

Corticium citrinellum, *Berk. & Curt.* Suborbiculare, resupinatum, citrinum demum pallidum, margine tenuissimo pulveraceo-arachnoideo; hymenio granulato, pulverulento; sporæ ellipsoideæ, $5 \times 3\,\mu$.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 336. (Type in Herb. Berk. Kew. 4002.)

On bark. Cuba. In very small scattered patches, citron or whitish, thin, farinaceous or pulverulent; margin indeterminate, mealy.

Corticium flavo-rubens, *Berk. & Broome.* Sparsum irregulare sulfureum, centro demum rubens pulveraceum.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 72.

Ceylon. From 2–3 lines across.

There is no specimen in Berkeley's herbarium; consequently I am not able to add to the above brief diagnosis.

Corticium Carlylei, *Massee*, n. sp. Elongato-effusum, adglutinatum, ceraceo-molle, glabrum, ambitu albo mox evanido; hymenio levi, nudo, sordide aurantio, sicco contiguo; sporæ cylindraceo-ellipsoideæ, utrinque obtusæ, curvulæ, 18–20 × 5–6 μ. (Type in Herb. Kew.)

On oak-bark. Britain (Carlisle, *Dr. Carlyle*).

Forming elongated patches often several inches in length by one inch broad, very closely attached to the matrix, and, when dry, contracting below the level of the bark. Hymenium rather shining, of a dirty orange, with sometimes a shade of fulvous; when in full vigour, there is usually a very narrow whitish margin, which, however, generally disappears with age. The hymenium does not change colour in drying, neither does it become in the least cracked.

Corticium vagum, *Berk. & Curt.* Late effusum; subiculo arachnoideo reticulato flavido subfulvo; hymenio ochraceo e floccis repentibus apice sporiferis enato, fibrillas ambiente; sporæ globosæ, 7–8 μ.—*Berk. & Curt. in Grev.* i. p. 179. (Type in Herb. Berk. 4033.)—*Exs.*: Ellis, N. A. Fungi, 330; Rav. Fung. Amer. 132.

On bark and wood. United States.

"Subiculum forming a reticulate spidery web, round the reticulations of which the hymenium is formed at the top of short processes, varying from dirty white to pale tawny." (*Berkeley.*)

Broadly effused, thin, indeterminate, inseparable; hymenium often porous and imperfect.

Corticium subsulphureum, *P. Karst.* Elongato-effusum, adglutinatum, subgrumoso-induratum, immarginatum, subsulphureum, glabrum; hymenio lævi, siccitate rimoso, nudo; sporis ellipsoideis vel oblongatis, hyalinis, 4–6 × 1–3 μ.—*P. Karst. Symb. Myc. Fenn.* viii. p. 12.

On old pine-wood. Finland.

Corticium Liquidambris, *Berk. in herb.* Irregulariter effusum, adglutinatum, carnoso-molle, ambitu tenui, pallido; hymenio ochraceo-fulvo, demum rimoso, interstitiis sericeis; sporæ subglobosæ, 7–8 vel 7 × 8 μ. (Type in Herb. Berk. n. 4070.)

On bark of *Liquidambar*. Alabama.

Broadly and irregularly effused, rather thick, often much

cracked quite through the entire substance; the hymenium cracked separately.

Corticium jaganicum, *Speg.* Alutaceum, crassiuscule membranaceum, late effusum, matrici totum adnatum, facile tamen corii instar separabile, molle, tenacellum, margine determinatum, repandum, sæpe attenuato-evanescens, non reflexum, planum, levissimum, in sicco non vel vix hinc inde rimulosum atque ambitu corrugato-subreflexum; sporis ellipticis v. ovatis, 5–6 × 3–3·5, hyalinis, levibus.—*Speg. Fung. Fueg.* n. 97.

On decorticated branches. Island of Aicina, Beagle Channel, Tierra del Fuego.

Corticium isabellinum, *Fr.* Effusum, late incrustans, byssaceo-tomentosum, isabellinum, ambitu concolore; hymenio papilloso, pulveraceo; sporæ ellipsoideæ, 10 × 5 μ.—*Fr. Hym. Eur.* p. 660; *Wint. Krypt. Fl.* 328.

On wood. Europe.

Effused, broadly adnate; margin defined, rather thick; hymenium generally confined to certain isolated patches on the surface, dirty buff, with a shade of pink, sometimes minutely cracked, powdered with the spores. Barren portion dirty ochraceous.

Corticium flavidum, *Berk. & Curt.* Subiculum obsoletum; hymenio e floccis repentibus ramosis apice sporas flavidas subglobosis botryoideas ferentibus; sporæ subglobosæ, 5 × 4 μ.—*Berk. & Curt. in Grev.* i. p. 178. (Type in Herb. Berk. 4075.)

On decayed wood. Pennsylvania.

"Subiculum obsolete; hymenium consisting of branched creeping threads, each branch of which bears at the tip a cluster of dirty yellow subglobose spores." (*Berkeley.*)

Very thin and indeterminate. Agreeing in habit with the loosely felted form of *C. arachnoideum.* The fertile branches mentioned by Berkeley are erect threads which become branched at the apex, and produce several basidia. None of the specimens show a typical compacted hymenium.

Corticium flavescens, *Massee.* Late effusum, tenue, granulatum, albido-griseum, dein flavescens; sporæ hyalinæ, ellipsoideæ, 10 × 4–5 μ.—Hypochnus flavescens, *Bonorden, Handbuch*, p. 160; *Fuckel, Symb. Myc. App.* ii. p. 291.—*Exs.*: Syd. Myc. March. 1804; Fuckel, Fung. Rhen. 2396.

On bark, &c. Europe; United States.

Very thin, like a wash of paint on the bark, pale yellowish, indeterminate, broadly effused.

CORTICIUM FLAVEOLUM, *Massee*, n. sp. Effusum, membranaceum, matrici laxe adhærens, margine determinatum; hymenio glabro, pallide flavente; sporæ cylindraceo-ellipsoideæ, utrinque obtusæ, $7 \times 5\ \mu$. (Type in Herb. Kew.)

On trunk of tree-fern. Britain (Kew).

Two or three inches broad, suborbicular or variously lobed, clear but pale primrose-yellow.

CORTICIUM ECHINOSPORUM, *Ellis*. Effusum, indeterminatum; hymenio sulphureo-flavo, tenui, molli, submembranaceo, subiculo floccoso laxe compacto marginemque evanidum; sporæ globosæ, echinulatæ, 4–5 μ diam.—*Ellis in Bull. Torr. Club*, 1881, p. 64.—*Exs.*: Ellis, N. Amer. Fung. 608.

On wood and bark of pine. N. America.

Forming a thin, separable, pale yellow film, indeterminate; patches connected by white cobweb-like byssoid mycelium. Hymenium minutely pulverulent. A fine and well-marked species.

CORTICIUM EMPLASTUM, *Berk. & Broome*. Effusum, tenue, substrato niveo marginem angustum efformante; hymenio glaberrimo alutaceo rimoso; sporæ ellipsoideæ, $5 \times 3\ \mu$.—*Berk. & Broome in Journ. Linn. Soc. (Bot.)* xiv. p. 70. (Type in Herb. Berk. n. 3957.)

On dead wood. Ceylon.

Consisting at first of small patches which usually become confluent; plant very thin, margin byssoid; hymenium sometimes reddish brown, becoming cracked and showing the white fibrillose subiculum.

CORTICIUM CERACEUM, *Berk. & Rav.* Resupinatum, effusum, adglutinatum, immarginatum, armeniacum, subiculo pallidiore; hymenio glaberrimo, nitido; sporæ cylindraceo-ellipsoideæ vix curvulæ, 18–20 × 7–8 μ.—*Rav. Fung. Car.* n. 29.—Corticium molle, *Berk. & Curt. in Cuban Fungi*, n. 446.—*Exs.*: Rav. Fung. Amer. 453; Ellis, N. Amer. Fung. 607; Fung. Cub. Wrightiani, 446. (Type in Herb. Berk. 3959.)

On bark and wood. United States; Cuba.

Broadly effused, sometimes with a well-defined margin; hymenium brownish ochre, waxy, cartilaginous looking, much con-

tracted in drying, sometimes cracked and showing the pale fibrilline subiculum.

The present species was first named *Corticium ceraceum*, and issued in Ravenal's Exsiccati under that name, and was afterwards described by Berkeley as *Corticium molle* by mistake.

CORTICIUM CROCICREAS, *Berk. & Curt.* Subiculum amplum, tomentosum, læte luteum; hymenio tenui, flavo, rimoso; sporæ ellipticæ, $5 \times 6 \times 3\ \mu$.—*Berk. & Curt. in Grev.* i. p. 178. (Type in Herb. Berk.)—*Exs.*: Rav. Fung. Car. Cent. 5, n. 27.

On wood. United States.

"Subiculum spreading widely, bright saffron-yellow; hymenium thin, more or less yellow. A curious species." (*Berkeley.*)

In the original description the subiculum is described as "læteritio," a printer's error for "læte luteo" as corrected by Berkeley.

CORTICIUM CÆRULEUM, *Fr.* Late effusum, adnatum, tomentosum, amœne cæruleum, ambitu byssino concolore subalbicante; hymenio ceraceo-molli, sicco pallescente; sporæ ellipsoideæ, $8 \times 4\ \mu$.—*Fr. Hym. Eur.* 651; *Berk. Outl.* 274; *Cooke, Handb.* i. 322; *Stevens. Brit. Fung.* p. 277; *Wint. Krypt. Fl.* 335.—Auricularia phosphorea, *Sow.* t. 350. Thelephora cærulea, *Berk. in Sm. Eng. Fl.* v. p. 168.—*Exs.*: Crypt. Lusitan. 6; Cooke, Fung. Brit. 221, ed. 2, 5; Roum. Fung. Sel. Gall. 505; Sacc. Myc. Ven. 106; Lib. Pl. Crypt. Ard. fasc. i. 22; Westendorp, Cr. Belg. 767; Rav. Fung. Amer. 451; Rav. Fung. Car. 3; Thuem. Myc. Univ. 1207; Desmaz. Crypt. Fr. 307.

Irregularly effused, adnate, or sometimes with the extreme margin free; margin fibrous, radiating, buff, or whitish; hymenium when in full vigour intense blue, satiny, often becoming pale in the centre. Said to be phosphorescent.

On wood. Britain; Europe; N. America; India; Ceylon; Madeira; Australia.

CORTICIUM VIOLACEO-LIVIDUM, *Fr.* Subeffusum, adnatum, induratum, violaceo-lividum, ambitu pallidiore; hymenio spurie corrugato, tuberculoso; pruina tenui albida consperso; sporæ cylindraceo-ellipsoideæ, curvulæ, $8 \times 4\ \mu$.—*Fr. Hym. Eur.* 655; *Wint. Krypt. Fl.* 332; *Stevens. Brit. Fung.* 280; *P. Karst. Myc. Fenn.* 318. (Specimen from Fries in Herb. Berk.)—Thelephora

livida, *Sommerf. Lapp.* p. 283.—*Exs.*: P. Karst. Fung. Fenn. 626; Roum. Fung. Gall. 1602.

On wood. Scotland; N. Europe; Pegu.

Closely adnate, continuous, hymenium dingy purple when dry, margin paler.

Corticium plumbeum, *Fr.* Interrupto-effusum, arcte adnatum, immarginatum, glabrum, chalybæum, rimosissimum, nudum.—*Fr. Hym. Eur.* p. 653.

On pine-wood. Lapland.

Corticium lividum, *Pers.* Effusum, arcte adnatum, ceraceo-molle, versicolor, ambitu similari; hymenio lævi, nudo, madido subviscido, sicco rimoso: sporæ cylindraceo-ellipsoideæ, 7–8 × 4 μ.—*Pers. Obs.* i. p. 38; *Fr. Hym. Eur.* 652; *P. Karst. Myc. Fenn.* 315; *Berk. Outl.* 275; *Cooke, Handb.* i. 323; *Stevens. Brit. Fung.* 278; *Wint. Krypt. Fl.* 374. (Specimen from Fries in Hb. B. 3990.) Corticium viscosum, *Fr. Elench.*—*Exs.*: P. Karst. Fung. Fenn. 625.

On wood. Britain; N. Europe.

Thin, closely adnate, irregular, smooth, slightly cracked when dry, bluish grey, with tinge of purple.

Corticium livido-cæruleum, *P. Karst.* Elongato-effusum, adglutinatum, ceraceo-molle, glabrum, livido-cæruleum; hymenio sicco, pruina albida densissima consperso, contiguo; sporæ ellipsoideæ vel oblongæ, inæquilaterales.—*P. Karst. in Nat. Soc. Fenn.* ix. p. 370; *P. Karst. Myc. Fenn.* p. 315; *Fr. Hym. Eur.* p. 652.

On rotten pine and birch. Finland.

Doubtfully distinct from *Corticium violaceo-lividum*.

Corticium fumigatum, *Thuem.* Amphigenum, late effusum, adglutinatum, membranaceum, tenue, e fusco fumosum, ambitu concolore, similari; hymenio nudo, rimoso, expallente, sicco fumoso, subpruinoso, subpapilloso, papillis sparsis, rotundatis, minimis; sporæ cylindraceo-ellipsoideæ, 7–8 × 3 μ.—*Thuem. in Bull. Torrey Bot. Club*, v. p. 95.—*Exs.*: Ellis, Fung. N. Jersey, U.S.A. 2880.

On branches. United States.

Superficially resembling broadly effused forms of *Peniophora cinerea*, but is a true *Corticium*, readily distinguished by its dark ashy tint and narrowly elliptical spores.

Corticium fumosum, *Fr.* Irregulariter effusum, molle, subtus ambituque tomento fumosum (fusco-canum); hymenio ceraceo, glabro, albo-pruinoso.—*Fr. Epicr.* p. 562; *Fr. Hym. Eur.* 651; *Fr. Icon.* 198.—Hypochnus fumosus, *Fr. Obs.* ii. p. 279 (sterile mycelium of above species).

N. Europe. On rotten wood, usually fibrous and sterile. Fries states that he only once met with a fertile specimen on dry leaves. It is doubtful whether the reference to Karst. Myc. Fenn. given by Fries refers to the right species, as the specimen (in the Kew copy) in Karst. Fung. Fenn. n. 916, called "*Corticium fumosum*," Fr., is a true *Thelephora* with brown, globose, warted spores.

Corticium cærulescens, *P. Karst.* Gossypinum, cærulescens, ætate expallens, effusum, tenue, confluens, ambitu conformi; hymenio papilloso; sporis sphæricis, 3–5 μ diam., levibus, cærulescentibus.—Lyomyces cærulescens, *P. Karst. Hattsv.* ii. p. 154.

On bark of birch. Finland.

Not a good *Corticium*, probably a *Chromosporium*.

Corticium Bupleuri, *Roum.* Effusum, adglutinatum, tenuissimum, indeterminatum; hymenio cinereo, sicco rimoso; sporæ ellipsoideæ, 6 × 3 μ.—(*Roum. Fung. Gall.* n. 1804.)—Corticium Friesii, *Grog. Pl. Cell. de Saône-et-Loire, in Rev. Myc.* t. iv. p. 19.

On *Bupleurum fruticosum*. France.

Like a thin grey wash of paint on the skin, margin sometimes minutely byssoid. With a superficial resemblance to *Peniophora cinerea*, but very much thinner, and a true *Corticium*.

Corticium prasinum, *Berk. & Curt.* Subiculum tenuissimum, arachnoideum; hymenio tenui, fragili, prasino; margine albo; sporæ ellipsoideæ, 9 × 5 μ.—*Berk. & Curt. in Grev.* i. p. 179. (Type in Herb. Berk. n. 4083.)

On the ground under *Liquidambar*. Alabama.

"Subiculum delicate, spidery; hymenium thin, brittle, continuous, with a white margin when young." (*Berkeley*.)

Very thin, bluish green or yellowish green, separable.

Corticium helvelloides, *Massee.* Late effusum, crassum, e spongioso induratum; hymenio tuberculoso, e pallido olivaceo-fusco, sicco rimoso; sporæ ellipsoideæ, 8–9 × 6 μ.—Thelephora

helvelloides, *Schwein. Syn. Car.* 1041; *Syn. N. Amer. Fung.* 668; *Fr. Epicr.* p. 541. (Specimen from Schweinitz in Herb. Berk.)

On the ground and on wood. U. States.

Broadly effused, thick, apparently more or less spongy when fresh, becoming rigid when dry; hymenium dark, cracked. In one part of the specimen I have seen, the under portion of the subiculum runs off into a few thick rhizomorphoid cords, which appear to have extended into the substratum.

CORTICIUM FILAMENTOSUM, *Berk. & Curt.* Subiculum molle, tomentosum, fibrillosum, pallidum; hymenio pulverulento demum glabrato, ochraceo vel subolivaceo; sporæ oblongo-ellipsoideæ, 6×3 μ.—*Berk. & Curt. in Grev.* i. p. 178. (Type Herb. Berk. 3999.)

On wood. Alabama.

"Subiculum consisting of soft tomentose threads, over which the ochraceous or olivaceous pulverulent hymenium forms a thin stratum." (*Berkeley.*)

Membranaceous, like a thin skin but not cartilaginous, tender and run over with thick branched filaments. Hymenium for the most part downy and barren, but here and there smooth, even, and minutely cracked when dry. Whole plant separable from the substratum.

CORTICIUM FLAVO-VIRENS, *Massee.* Late effusum; hymenio pulverulento rhabarbarino in pulvinulos fracto, e floccis byssoideis flavis oriundo; sporæ ellipsoideæ, 10×6 μ.—Corticium reticulatum, *Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 69. (Type in Herb. Berk. Kew. n. 4028.)

On bark. Ceylon.

Broadly effused, adnate, spongy, broken up in a sinuous or reticulate manner, minutely velvety under a lens, cracked in a tesselated manner; margin radiato-fimbriate; colour when dry yellowish green. The name given by Berkeley and Broome is antedated by Fries.

CORTICIUM CHLORINUM, *Berk. & Curt.* Tenue, fragile, olivaceum demum granulatum; sporæ ellipsoideæ, 7×5 μ.—*Berk. & Curt. in Grev.* i. p. 179. (Type in Herb. Berk. n. 4059.)

On *Abies*. Alabama.

Forming a thin brittle olive-green membrane, which is at

first pulverulent, but afterward rough with minute papillæ; resembling such *Thelephoræ* as *T. laxa*, &c.

Forming a thin separable film.

Corticium atro-virens, *Fr.* Irregulariter effusum, tenue, atro-virens, subtus et ambitu tomentosum, concolor; hymenio ceraceo, glabro, albo-pruinoso; sporæ subglobosæ, 4–5 μ diam.—*Fr. Hym. Eur.* 651; *Berk. Outl.* 273; *Cooke, Handb.* i. 323; *Stevens. Fung. Brit.* 277.

On rotten wood, leaves, sticks, &c. Britain; Sweden.

Effused, very thin, blackish or verdigris-green; hymenium when perfect paler, glaucous and waxy; margin indeterminate.

C. *Amphigena, tenuissima, innata, decorticantia.*

Corticium nigrescens, *Fr.* Effusum, interruptum, epidermide avulsa nudum, innatum, tenue, e lutescente nigrescens; hymenio subinde papilloso, ceraceo, subpruinoso; sporæ cylindraceo-oblongæ, utrinque obtusissimæ, curvulæ, 18–20 × 5–6 μ.—*Fr. Epicr.* p. 565; *Hym. Eur.* p. 656.—Thelephora nigrescens, *Schrad. Spic.* p. 186.—*Exs.*: Syd. Myc. March. 1707.

On branches. Britain; Europe.

Originating underneath the bark, with the habit of *Corticium comedens*, from which it is readily distinguished by being pale at first and then becoming blackish, whereas *C. comedens* is purple and becoming whitish when old. Effused, very thin, agglutinated, indeterminate; hymenium waxy, powdered with the very large spores.

Corticium comedens, *Fr.* (Pl. VI. f. 5.) Effusum, innatum, subcorticale; epidermide divulsa nudum, e lilacino pallescens; hymenio lævi, glabro, sicco rimoso; sporæ cylindraceo-ellipsoideæ, interdum curvulæ, 14–16 × 6–7 μ.—*Fr. Hym. Eur.* 656; *Berk. Outl.* 276; *Cooke, Handb.* i. 325; *Stevens. Brit. Fung.* 281; *P. Karst. Myc. Fenn.* 318; *Wint. Krypt. Fl.* 331.—Thelephora comedens, *Nees, Syst.* f. 255. Thelephora decorticans, *Pers. Myc. Eur.* i. p. 137.—*Exs.*: Rabenh. Fung. Eur. 412, 412 *b*; Fuckel, Fung. Rhen. 1309; Roum. Fung. Gall. 2012; Sydow, Myc. March. 408; P. Karst. Fung. Fenn. 53; Thuem. Fung. Austr. 329; Berk. Brit. Fung. 22; Thuem. Fung. Univ. 514.

On branches, especially hazel. Britain; Europe; N. America; Ceylon; S.E. Australia.

Originates below the bark, which eventually becomes torn and reflexed, exposing the hymenium, which is at first purplish, becoming almost white; slightly viscid when moist.

Corticium latitans, *P. Karst.* Effusum, admodum tenue, adnatum, subcorticale, epidermide divulsa nudum, album, ambitu indeterminato subbyssino; hymenio tenuissimo, submembranaceo, contiguo, papillas sat confertis minutis, conoideis instructo, dilutissime lutescente; sporis oblongatis vel ellipsoideo-oblongatis, rectis vel curvulis, utrinque obtusissimis, primitus guttulis 2 majusculis præditis dein e guttulatis vel tenuiter uniseptatis, hyalinis, $9–15 \times 4–5\ \mu$.—*P. Karst. in Rev. Myc.* p. 74 (1888).

On decayed branches of *Pyrus Aucuparia.* Finland.

Sterile hyphæ branched, septate, very thin, hyaline, $3–5\ \mu$ thick; basidia $6\ \mu$ thick.

From the description it appears doubtful whether this species is more than a mere form, not even variety, of *Corticium comedens.*

Corticium uvidum, *Fr.* Late effusum, tenuissimum (ligno nec ut priora cortici), subinnatum, ramos decorticatos ambiens, e roseo-lilacino expallens; hymenio lævissimo, glaberrimo madido; sporæ fusiformi-ellipsoideæ, $6 \times 2–3\ \mu$.—*Fr. Epicr.* p. 565; *Fr. Hym. Eur.* p. 657.—*Exs.*: Sydow, Myc. March. 1607.

On fallen branches of beech. Sweden.

Habit of *C. comedens*, but very thin, and with very much smaller and different-shaped spores.

D. *Species dubiæ.*

Corticium Berkeleyanum, *Ces.* Lignicolum; crusta effusa, indeterminata, ex helvolo luteola, superficie æquabili, a matrice non solvenda.—*Ces. Myc. Born.* p. 10.

Borneo.

Corticium lilaceum, *Rabenh.* C. matrici arcte adpressum, effusum, crustaceum, rimosum, constanter lilacinum, margine nudo, papillis sparsis.—Thelephora lilacea, *Rabenh. in Bot. Zeit.* 1853, p. 235.

On bark. Italy.

Allied to *Corticium calceum.*

CORTICIUM HYPOCHNOIDEUM, *Berk. & Curt.* Pusillum, stellato-orbiculare, rubrum, margine elevato; hymenio demum atro-vinoso; sporæ....?—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) xiv. p. 71. (Type in Herb. Berk. Kew. n. 3964.)

On dead wood. Ceylon.

Sometimes erumpent, at others superficial, consisting of minute circular patches ·5 centim. across. Very thin, margin free, raised, pale below, several sometimes confluent; spores not seen, the specimens are evidently immature.

CORTICIUM AURIFORME, *Berk. & Curt.* Auriforme; pileo zonato postice albido rugoso glabrescente, antice umbrino velutino; hymenio rimoso ex ochraceo rufo.—*Berk. & Curt. Fung. Car. Inf.* No. 2380.

On oak.

Pileus ear-shaped, 1½–2 inches across; dirty white behind, rugose and nearly smooth, zoned in front; the extreme edge umber, velvety. Hymenium at first ochraceous, then rufous, cracked, the cracks at first radiating.

There is no specimen of the above in the Berkeley Herbarium, and judging from the description alone the species cannot be a true *Corticium*, but rather a *Stereum*.

CORTICIUM BICOLOR, *Peck.* Tenue, membranaceum, flaccidum, glabrum, e matrice separabile, subtus viridi-luteum, superne album.—*Peck in* 26*th Report N. York State Mus.* p. 72.

On rotten wood. Center, New York.

CORTICIUM VIRIDE, *Preuss.* Effusum, membranaceum, tenue, ochraceo-virens, ambitu concolore, glabro; hymenio setulis erectis albis sparsis vestito; papilis rotundatis, magnis, sparsis; sporis ovatis.—*Preuss. in Linnæa*, 1851, p. 152.

On damp wood of *Pinus sylvestris.* Europe.

Evidently not a good *Corticium* as at present defined.

CORTICIUM? ULMI, *Lasch.* Late effusum, subcarnoso-membranaceum, e cinereo ochraceum; ambitu albo-radiato; hymenio dense papilloso, albo pulverulento, sporis subrotundo-ovoideis. —Thelephora Ulmi, *Lasch, in Bot. Zeit.* 1853.

On elm. Germany.

It is difficult to say from the above description whether the species is a *Corticium* or a resupinate *Stereum.* It cannot be a *Thelephora* as now understood.

CORTICIUM TERREUM, *Berk.* Resupinatum, terreo-fuscum, subvinosum, primo contiguum, dein areolato-rimosum, setulosum; margine angustissimo.—*Berk. in Hook. f. Fl. N. Zeal.* p. 184. (Type in Herb. Berk. n. 4004.)

On bark. New Zealand.

The type specimen is sterile, and looks like an immature *Thelephora.*

CORTICIUM SUFFULTUM, *Berk. & Broome.* Effusum, album vel cinnamomeum; hymenio molli tomentoso processibus niveis floccosis suffulto.—*Berk. & Broome in Journ. Linn. Soc. (Bot.)* xiv. p. 72. (Type in Herb. Berk. n. 4015.)

On dead twigs. Ceylon.

Effused, closely adnate, rather thick and spongy, often immarginate; no spores nor even any trace of a hymenium were met with in an examination of the type specimens, which present the appearance of an immature condition of some species.

CORTICIUM DIMINUENS, *Berk. & Curt.* Album, stratosum; hymenio cretaceo diminuente subtiliter velutino; sporæ ellipticæ, 10×5–$6\ \mu$.—*Berk. & Curt. in Grev.* ii. p. 3. (Type in Herb. Berk. Kew. 4009.)—*Exs.*: Ellis, N. Amer. Fung. 718; Rav. F. Car. 3.

On wood. U. States; Havana.

Consisting of several layers, each separated by a dark line; hymenium white, diminishing in width each time of growth so as to leave a narrow-zoned border. (*Berkeley.*)

Broadly expanded, adnate, thickish, rarely cracked; hymenium when dry often ochraceous or with a livid tinge, very minutely woolly, almost resembling a *Peniophora* under a lens, but there are no cystidia. Evidently not a good *Corticium.*

STEREUM, *Pers.* (emend.).

Hymenium definite inferum, coriaceum, strato intermedio fibrilloso a pileo inodermeo distinctum, leve, glabrum, immutatum persistens; sporæ continuæ, hyalinæ vel olivaceæ.—Stereum, *Pers. Obs. Myc.* p. 35; *Fr. Epicr.* p. 345 (in part); *Fr. Hym. Eur.* p. 638 (in part).

The prominent features of the present genus are the inferior hymenium, which is glabrous owing to the absence of cystidia or coloured setæ (modified cystidia), and the velvety or strigose

pileus. In *Peniophora* and *Hymenochæte* the general habit is the same, but in both the hymenium is minutely velvety or setulose. In the present genus there is an unbroken sequence from the central-stemmed type, with a more or less funnel-shaped pileus and inferior hymenium, through the lateral-stemmed or flabelliform, to the effused stage, with a more or less developed free margin, or several free margins spring from the effused and adnate portion in a dimidiate manner; this last runs by degrees into the lowest stage, where the plant is closely adnate to the substratum by its under surface and having the hymenium uppermost, thus closely agreeing in habit with the normal condition in the genus *Corticium*, but distinguished by the presence of a zone of closely compacted hyphæ which directly gives origin to the elements of the hymenial layer; from the underside of this layer a looser felt of hyphæ penetrate the substratum. In *Corticium* no such intermediate layer exists. Again, in *Stereum*, as a rule the hymenium does not become cracked when dry as in *Corticium*, and the margin is rarely indeterminate, but in most adnate forms more or less free and strigose.

I. *Pileus subinfundibuliformis, stipite distincto, centralis, rarius obsoletus.*

Stereum cyathiforme, *Fr.* (Pl. VII. f. 3.) Coriaceum, albidum; pileo late cyathiformi setoso, margine acuto integro; stipite hymenioque nudo glabris lævibus; sporæ globosæ, 4–5 μ. —*Fr. Epicr. Syst. Myc.* p. 245.—Thelephora cyathiformis, *Fr. in Linnæa*, v. (1830) p. 523.

On the ground, probably springing from buried wood. Brazil; Cuba; New Guinea.

Pileus $1\frac{1}{2}$–$2\frac{1}{2}$ inches across, margin waved, silky or strigose; stem about half an inch long, central, smooth.

Stereum hydrophorum, *Berk.* Pileo infundibuliformi, fusco, umbrino, zonato, processibus longis amplis planis acute laciniatis dense stipatis concoloribus vestito; stipite rigido, tenui, subtiliter velutino; hymenio albido; sporæ ellipsoideæ, 6×4 μ.—*Berk. in Hook. Kew Journ. Bot.* viii. p. 273, pl. vi. (Type in Herb. Berk. Kew. n. 3788.)—Stereum Goliath, *Speg. Fung. Guar.* Pug. i. n. 70.

On the ground, in high woods on the river Uaupés, Brazil. Probably attached to concealed branches; also in woods near Rio Negro and Casiquiare.

Pileus 3–4 inches across, infundibuliform, chocolate-brown, coriaceous, repeatedly zoned, velvety, clothed, more especially in the centre, with a dense forest of flat branched, acutely laciniated, velvety processes continuous with the paler substance; edge lobed. Stem $\frac{1}{2}$–1 inch high, attached by a disciform base, round, nearly even, of the same colour as the pileus, obscurely velvety. Hymenium white or very pale umber, smooth.

Nothing can be more curious than the dense mass of processes with which the centre of the pileus is clothed, which, if torn from it, would certainly be described as a new species of branched *Thelephora*. In age the border has but few processes, and in old specimens they appear to be washed away, in which state the species was originally described, from specimens communicated by Sir E. Schomburgk, in Ann. Nat. Hist. xiv. (1844), p. 327. (*Berkeley.*)

Infundibuliform, 3–4 inches across; stem central, $\frac{3}{4}$ in. long, 3–4 lines thick, minutely velvety, ochraceous-umber; pileus thin, reddish-umber when dry, zoned, strigose, margin rugulose.

Var. HYLOCRATER, *Speg.* Var. pileo cyathoideo-infundibulari, 7 cm. diam., 5 cm. alt., coriaceo-membranaceo, rigidulo, superne concentrice subobsolete zonato, radiatim rugoso, interstitiis rugaram, præcipue ad confluentiam zonarum, sæpius tomento majusculo, flocculoso, albo-subgriseo vestito, ceterum glabro, ligneo pallescente; margine integro vel repando-subcrenato ac plus minusve dense tomentoso; hymenio albo-carneo, pulvere detersili albo adsperso, leniter flabellatim undulato; stipite tereti, hymenio concolore v. vix fuscescente, glabro v. irregulariter griseo-velutino, 1–1·5 cm. long., 3–4 mm. crass.—Stereum hylocrater, *Speg. Fung. Guar.* Pug. i. n. 71.

On putrescent decorticated wood. Paraguay.

Allied to *S. Goliath* (=*S. hydrophorum*), of which it is perhaps a young stage.

STEREUM ELEVATUM, *Berk. & Cooke.* (Pl. VII. f. 1.) Pileo cyathiformi, zonato, castaneo, subtiliter velutino; stipite elongato, irregulari, rugoso, pulverulento; hymenio striatulo, leviter zonato, pallido; sporæ globosæ, 4–5 μ diam.—*Berk. & Cooke in Journ. Linn. Soc.* (*Bot.*) xv. p. 388. (Type in Hb. Kew.)

On dead wood. Brazil (Rio Jurua).

Pileus 1 in. across, $\frac{3}{4}$ in. high, zoned, chestnut, minutely velvety; stem 4 in. high, $\frac{1}{4}$ in. thick, dilated and grooved at the apex,

where it becomes of a deep bay, more umber below. (*Berkeley & Cooke.*)

STEREUM MIQUELIANUM, *Mont.* Procerum; pileo parvo, supra castaneo, zonis obscurioribus notato, infundibuliformi, in lacinias paucas, erectas, simul concretas, flabelliformes, dein ad stipitem usque longissimum lignosum usque diviso; hymenio glabro, pallido.—*Mont. in Amst. Tijds. Wetens.* iv. (1851) 203; *Syll. Crypt.* 584.

On wood. Surinam.

STEREUM SURINAMENSE, *Lév.* Pileo coriaceo, infundibuliformi, nudo, fusco, subtus dilutiore; stipite hirsuto, sulcato, fusco.—*Lév. in Ann. Sci. Nat.* sér. 3, i. p. 209.

Surinam.

Allied to *Stereum elegans*, differing in the hirsute stem and absence of zones on the pileus. The same characters separate the present species from *S. nitidulum*, Berk. From 2–4 cm. high.

STEREUM PERGAMENUM, *Berk. & Curt.* Pileo cyathiformi, rufo, vix zonato, subtiliter lineato; margine tenui, dentato laceratove; stipite cylindrico hymenioque albidis vel pallide ochraceis; sporæ ellipsoideæ vel subglobosæ, $6–8 \times 5–6\ \mu$.—*Berk. & Curt. in Grev.* i. p. 161.—*Exs.*: Rav. Fung. Car. 3. (Type in Herb. Berk. n. 3742.)

On decayed wood and branches. Alabama; Amazon valley.

Pileus 1–1½ inch across, cup-shaped, bright rufous, not shining, minutely lineate, very obscurely zoned; margin thin, often toothed or laciniate; stem 1–1½ inch high, 1 line thick, whitish, very minutely tomentose; hymenium nearly of the same subochraceous tint. (*Berkeley, l. c.*)

The stem is very variable in length, sometimes almost obsolete, when the pileus appears attached by a central discoid base. Several plants often become confluent at the margin of the pilei.

STEREUM CAPERATUM, *Massee.* Mesopoda; pileo coriaceo-membranaceo, irregulariter infundibuliformi, rugoso-plicato, centro hirsuto fulvo; margine eroso-fimbriato aut inciso; hymenio pallido, rugoso; stipite centrali, crasso, tomentoso, scutatim affixo; sporæ ellipsoideæ, hyalinæ, $6–7 \times 4–5\ \mu$.—*Berk. et Mont. Cent.* vi. n. 69; *Mont. Syll. Crypt.* n. 579. (Type in Herb. Berk. n. 3737.)

On trunks. Bahia, Brazil; St. Domingo; Cuba; Moreton Bay and Clarence River, Australia; Lord Howe's Island.

Funnel-shaped, 5–6 inches across and deep; stem 1 inch long. Hymenium ochraceous or pinkish, with radiating rounded and bifurcating grooves. Pileus with numerous radiating sharp ridges, strigose, becoming smooth, ochraceous.

STEREUM ELEGANS, *Fr.* Cartilagineo-coriaceum; pileo infundibuliformi, glabro nitido rufescente fusco fasciato, margine undulato-plicato; stipite curto; hymenio lævi, pruinoso albo carneo; sporæ subglobosæ, 4–5 μ diam.—*Fr. Epicr.* p. 545.—Thelephora elegans, *Fr. Syst. Myc.* i. p. 430. Thelephora floriformis, *Schweinitz* (from authentic specimen from Schweinitz in Hb. Berk. from U.S.).—*Exs.*: Fungi Cubenses Wrightiani, 389.

On the ground. Brazil; St. Domingo; Cuba; Venezuela; Ceylon; Bombay; Tasmania; Australia; N. Zealand; Malabar.

Pileus $\frac{2}{3}$–$1\frac{1}{2}$ inch across, usually infundibuliform, sometimes flabelliform, often bright bay-brown or chestnut, shining; stem slender, about 1 inch long, often shorter.

STEREUM DIAPHANUM, *Cooke.* *S.* pileo infundibuliformi, pallido, diaphano, striato; stipite gracili; hymenio albido.—Thelephora diaphana, *Schwein. in Journ. Acad. Nat. Sc.* 1853, p. 278.

On the ground. N. America.

Pileus and stem together 3·5–4 cm. high; stem loosely covered with white tomentum; hymenium dirty white, becoming more or less rufous. Almost the habit of *Thelephora aurantiaca*, but less elegant.

STEREUM ALUTACEUM, *Berk. & Cooke.* Pusillum, cæspitosum, alutaceum; pileo infundibuliformi, lineato-striato; stipite gracili; sporæ globosæ, 5 μ diam.—*Berk. & Cooke in Journ. Linn. Soc.* (*Bot.*) xv. p. 388. (Type in Herb. Berk. n. 3753.)

On dead wood. Brazil; Rio Mauhes, below the rapids.

About an inch high including the stem, buff, infundibuliform, finely striate; stem $\frac{1}{2}$ in. high, slender, dilated above into the pileus.

STEREUM FULVO-NITENS, *Berk.* *S.* pileo rigido, tenui, profunde infundibuliformi, nitido, creberrime zonato, hymenioque lævi glabro fulvis; stipite brevissimo, nigro; sporæ ellipsoideæ,

$5 \times 3\ \mu$.—*Berk. in Ann. Nat. Hist.* ser. 2, ix. 1852, p. 198. (Type in Herb. Berk. n. 3741.)

On dead wood. St. Domingo.

Pileus infundibuliform, shining, of a bright coppery tint, with close, narrow zones of a darker tint, finely striate; hymenium duller; stem about $\frac{2}{3}$ in. long, 2 lines thick. Allied to *S. elegans*, but distinguished by its more regular shape and clearer, brighter colours.

Stereum Mellisii, *Berk.* Coriaceum, rigidum, fuligineum; pileo infundibuliformi, glabro, atro-fuligineo; margine acuto, integro, pallido; stipite velutino demum subglabro, pallidiore, recto curvatove, basi discoideo; hymenio lævi, badio-fuligineo; sporæ ellipsoideæ, $5 \times 3{\cdot}5$–$4\ \mu$.—*Berk. in Grev.* xiii. p. 3. (Type in Herb. Berk. n. 3740.)

On trunks. St. Helena; New Guinea; Perak; Malacca.

Infundibuliform; stem $\frac{1}{2}$–$\frac{2}{3}$ inch long, discoid at the base; hymenium smooth, mouse-colour with shade of brown; pileus blackish umber, thin.

Stereum nitidulum, *Berk.* *S.* pileo infundibuliformi, submembranaceo, rigidiusculo, crenato, glabro, nitidulo, zonato, brunneolo; stipite centrali, tenui; hymenio albo; sporæ subglobosæ, 3–4 μ diam.—*Berk. in Hook. Lond. Journ. Bot.* ii. p. 638. (Type in Herb. Berk. n. 3748.)

Cuba; St. Domingo; Ceylon; Australia; Himalayas; Brazil. On a rotten stick covered with sand, on the Rio de Mauvel Alvez, Prov. of Goyaz.

Pileus about half an inch broad, infundibuliform, thin, submembranaceous, but rather rigid, brownish, with a tinge of red, marked with darker zones, smooth, shining.

Stem $\frac{1}{4}$–$1\frac{1}{2}$ inch long, about 1 line thick. Hymenium covering part only of the under surface, white. (*Berkeley.*)

Stereum partitum, *Berk. & Broome.* *S.* pileo ex infundibuliformi, fisso, brunneo, lineato; stipite brevissimo, obsoleto; hymenio pallidiore, rimoso; sporæ 7×4–$5\ \mu$.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 65. (Type in Herb. Berk. 3763.)

On dead wood. Ceylon; Brazil.

From 1–2 in. high and broad, whole plant pale, substance thin, splitting; stem hispid.

STEREUM RAVENELII, *Berk. & Curt.* (Pl. VII. f. 2.) Gregarium, e communi mycelio oriundum; pileo cyathiformi, fusco; margine pallidiore, plicato; stipite gracili, tomentoso hymenioque pallidis; sporæ ellipticæ, $6 \times 4\ \mu$.—*Berk. & Curt. in Grev.* i. p. 162. (Type in Herb. Berk. n. 3743.) *Exs.*: Rav. Fung. Car. 4.

On the earth in swamps and on decayed wood. Alabama; Brazil.

Pileus very variable in size, from a line to an inch across, cup-shaped, sometimes split on one side, brownish with a slight admixture of red, paler towards the plicate margin; stem $\frac{1}{2}$–$1\frac{1}{2}$ inch high, $\frac{1}{2}$ a line thick, gregarious, springing from a common mycelium, finely tomentose, pallid as well as the hymenium. Closely allied to *S. nitidulum*, Berk. (*Berkeley, l. c.*)

The hymenium is sometimes pale cinnamon or ochraceous when dry. Several plants often becoming confluent by the edges of the pilei.

STEREUM SOWERBEII, *Massee.* Niveum, infundibuliforme, tandem decolorans, sursum aculeato-scabrum; hymenio e setuloso; sporæ ellipsoideæ, hyalinæ, $5 \times 4\ \mu$.—Thelephora Sowerbeii, *Berk. Outl.* p. 266, *et in Ann. Nat. Hist.* ser. 3, xv. p. 320; *Fr. Hym. Eur.* 632. (Type from Sowerby's herbarium in Herb. Berk. n. 3553.)—Elvella pannosa, *Sowerby*, t. 155.

On the ground. Britain; United States; Australia.

Mr. Sawyer has at last met with the true plant of Sowerby at Burnham Beeches, where it has since been seen by others. When fresh it is of a pure white; though when exposed to the weather it assumes a dingy yellow tinge here and there, and therefore cannot be the same as the Cotterstock plant described below, of which we now give a figure. The hymenium is not in the slightest degree setulose. The pileus is rough, with radiating processes projecting from the surface. Sowerby's figure was evidently taken from discoloured specimens, but is very faithful. (*Berkeley.*)

From 1–2 inches high; resembling in form *Craterellus cornucopioides* in miniature; margin of pileus more or less laciniate or cut; stem variable, sometimes distinct and thin, at others several more or less confluent at the base. The spores and very compact substance prove the plant to be a *Stereum*. It has no affinity with *Cladoderris* as suggested by Fries in Summa Veg. Scand. p. 332.

STEREUM XANTHELLUM, *Cooke.* Coriaceo-membranaceum, ochraceo-flavidum; pileo infundiduliformi, glabro, opaco, leviter

subzonato; margine undulato; stipite deorsum attenuato, tenui; hymenio pruinoso, concolore; sporæ ellipsoideæ, $5 \times 3\ \mu$.—*Cooke, Grev.* ix. p. 12. (Type in Herb. Kew.) *Spruce, Lichenes Amazonici et Andini*, 812.

Resembling *S. elegans*, Fr., in size and form, but very different in colour and texture. It has very much the appearance of new washleather. Stem about the same length as the pileus, about an inch. (*Cooke.*)

Stereum Thozetii, *Berk.* *S.* pileo infundibuliformi, tomentoso, demum radiato, subzonato, pallido; hymenio rimoso, ex albido castaneo, polito; sporæ globosæ, 5–6 μ.—*Berk. Australian Fungi*, n. 268. (Type in Herb. Berk. Kew. n. 3744.)

On trunks. Rockhampton, Australia.

Pileus 1–2·5 cm. across; stem scarcely 2 cm. long, attenuated downwards.

Stereum tenerrimum, *Berk. & Rav.* Pusillum; pileo cyathiformi, cito lacerato, tomentoso, pallido, glabrescente; stipite filiformi; sporæ globosæ, 3 μ.—*Berk. & Rav. in Grev.* i. p. 162.

On the ground amongst grass and mosses. Upper Carolina.

Pileus 2–3 lines broad, cup-shaped, pallid, soon lobed and split, at first tomentose; margin sometimes deeply plicate; stem thread-shaped, $\frac{1}{3}$–$\frac{3}{4}$ inch high, whitish, tomentose; hymenium even or finely striate.

This is very different from small forms of *S. Ravenalii.* (*Berkeley, l. c.*)

Stereum Tuba, *Berk. & Broome.* (Pl. VII. f. 4.) Gregarium, ex infundibuliformi flabellatum, tenerum, pallide rufum vel griseum, in stipitem tenuem brevem angustatum; sporæ subglobosæ, 3 μ.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 65. (Type in Herb. Berk. n. 3764.)

On bark. Ceylon; tropical forests south of the island.

Gregarious or scattered, $\frac{1}{4}$–$\frac{1}{2}$ inch high, about one line across at apex, afterwards splitting down one side.

Stereum petalodes, *Berk.* Coriaceum; primitus infundibuliforme demum fisso-multipartitum; lobis striatis opacis subglabris; hymenio pallido, rimoso; sporæ ellipsoideæ, 7×3–$4\ \mu$.—*Berk. in Ann. Nat. Hist.* ser. 2, ix. 1852, p. 198. (Type in Herb. Berk. n. 3754.)

On wood and branches. St. Domingo; Java.

Not a good *Mesopod* form, but frequently laterally attached by a broad base for several inches; margin undulato-plicate, densely crowded, at first infundibuliform, soon split into numerous lobes, which are again more or less divided; dull reddish-brown, marked with long grooves or striæ; hymenium pale, much cracked, sometimes so much as to be granulated. Allied to *S. involutum*, but much more split and lobed, with an obsolete stem and paler hymenium. The hymenium is not granulated from the beginning, but merely in consequence of the frequent cracking of the fructiferous stratum.

STEREUM MOSELEI, *Berk.* *S.* pileo ex infundibuliformi flabellato, subtiliter velutino, subzonato, cervino; margine pallidiore; stipite e basi parva oriundo opaco pallido; hymenio rufulo; sporæ ellipsoideæ, 6×4 μ.—*Berk. in Journ. Linn. Soc.* (*Bot.*) xvi. p. 48. (Type in Herb. Kew.)

Malamon, upon sticks (‘*Challenger*’ *Exp.*). Victoria.

Pileus about $\frac{1}{2}$ in. across, stem $\frac{1}{4}$ in. high; sometimes several spring from the same confluent base; stem occasionally of the same colour with the hymenium. (*Berkeley.*)

Infundibuliform, gregarious, several pilei often grown together; stems thin, free.

STEREUM CALYCULUS, *Berk. & Curt.* Pusillum; pileo cyathiformi, subtiliter tomentoso, opaco, umbrino; stipite gracile, concolore; hymenio albido, obsolete venoso; sporæ globosæ, 5 μ diam.—*Berk. & Curt. in Hook. Kew Journ.* i. p. 238; *Grev.* i. p. 161. (Type in Herb. Berk. n. 5755.)

On dead wood. Southern United States.

Pileus cup-shaped, $\frac{1}{3}$ inch broad, extremely thin, umber, opaque, minutely tomentose; stem $\frac{1}{2}$ inch high, $\frac{1}{3}$ line thick, umber; hymenium whitish, very obscurely venose.

Allied to *Stereum curtum*, Fr., and *S. pusillum*, Berk., but especially to the latter, and distinguished by its very regular pileus, which is not at all shining or apparently zoned.

STEREUM BOLLEANUM, *Mont.* *S.* pileo cartilagineo-pergameno, initio infundibuliformi integro aut margine undulato-repando, demum ad stipitem usque centralem pruinoso-velutinum basique ramosum multipartito aut flabelliformi-explanato, supra e fulvo brunnescente lineis obscurioribus concentrice zonato radiato-

fibroso, glabro; hymenio glaberrimo, levi, ochraceo-pallido.—*Mont. Syll. Crypt.* n. 583.

On the ground. Island of St. Nicholas, Cape Verde.

Pileus 2 centim. high, $2\frac{1}{4}$–4 centim. broad; stem colour of pileus, 3–4 centim. long; about the thickness of a goose-quill.

Stereum multizonatum, *Berk. & Broome.* *S.* pileo multiplici infundibuliformi e variis lobis stipitibusque confluentibus oriundo, sursum læte carneo-rufo multizonato; margine lobato-crenulato; hymenio costulato, pallidiore, glabro; sporæ ellipsoideæ, hyalinæ, $8\text{–}9 \times 4\text{–}5\ \mu$.—*Berk. & Broome in Ann. Nat. Hist.* ser. 3, xv. p. 321, pl. xiii. f. 4.—Thelephora Sowerbeii, *Berk. Outl.* 266 (in part). Stereum carolinense, *Cooke & Rav. in Journ. Myc.* 1885, p. 130. (Type in Herb. Berk.)

On the ground. Britain; Germany.

Forming a dense mass, of a beautiful reddish tint; flesh and stem zoned within. This species is perfectly distinct from Sowerby's plant. (*Berkeley.*)

Stereum prolificans, *Berk.* Gregarium, infundibuliforme, stipite brevissimo; pileo sulcato-zonato, velutino, spadiceo; hymenio lævi, plicato, nitido, brunneo; sporæ ellipsoideæ, $7 \times 5\ \mu$.—*Berk. in Journ. Linn. Soc.* (*Bot.*) xvi. p. 41. (Type in Herb. Kew.)

Somerset, Cape York ('*Challenger*' *Exp.*).

Pileus 2 inches across, 1 inch high, with a number of young infundibuliform pilei at the base, with the hymenium superior or reniform, attached by a distinct orbicular base, repeatedly zoned and sulcate, of a rich brown; hymenium dark brown, sometimes slightly zoned. (*Berkeley.*)

Stereum Rivulorum, *Berk. & Curt.* Minutum, stramineum; pileo cyathiformi, in stipitem sursum dilatatum decurrente, margine undulato; hymenio glabro, pallido; sporæ globosæ, 2–2·5 μ.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 330. (Type in Herb. Berk. Kew. n. 3760.)

On wet ground amongst moss. Cuba.

Pileus very thin, more or less infundibuliform, $\frac{1}{2}$–$\frac{3}{4}$ inch across; stem 1–2 lines long, generally oblique, but not truly lateral.

Stereum cristatum, *Berk. & Curt.* Parvum, flabelliforme vel cyathiforme, pallidum, subzonatum, postice fibris pallidis

cristatum; hymenio levi, nitido, pallide ochraceo; sporæ subglobosæ, 5–6 μ. diam.—*Berk. & Curt. in Grev.* i. p. 163. (Type in Herb. Berk. Kew. n. 3781.)

On dead vines in swamps. Carolina.

Some of the specimens are distinctly mesopodous, others merely flabelliform, pallid, zoned, minutely lineate, clothed behind, or at the base of the cup, with distinct cylindrical processes. Scarcely half an inch across; stem, when present, cylindrical, scarcely a line long. (*Berkeley.*)

Stereum curtum, *Fr.* Coriaceo-membranaceum, undique glaberrimum; pileo plano-depresso, subfulvo, fasciato, stipiteque brevissimo nitentibus; hymenio levi, nudo, pallidiore.—*Fr. in Linnæa*, v. p. 523; *Epicr.* p. 545.

On wood. Tropics (country unknown).

Attached to the wood by the dilated orbicular base.

Stereum crucibuliforme, *Massee.* Crucibuliforme, extus hirsutum, margine inflexo; hymenio lævi, ad marginem cyathi, pallide umbrino, basin versus rubro-fusco; sporæ ellipsoideæ, 7×4 μ.—Stereum cyathiforme, *Currey, in Trans. Linn. Soc., Bot.* ser. 2, i. p. 127, pl. xxi. fig. 1. (Type in Herb. Kew.)

On wood. Pegu; Karen hills.

Currey's name is antedated by Fries. Plants about the size and closely resembling *Crucibulum vulgare.*

II. *Pileus spathulato-flabelliformis, basi in stipitem plus minus distinctum attenuatus.*

Stereum radiato-fissum, *Berk. & Broome.* *S.* pileis tenuibus, flabelliformibus, multifidis, subinvolutis vel basi divisa oriundis, spadiceis nitidis multizonatis, apice laceris; hymenio ochraceo; sporæ globosæ, 4 μ diam.—*Trans. Linn. Soc.*, ser. 2, *Bot.* ii. p. 63, pl. xiv. figs. 8–11. (Type in Herb. Berk. Kew. n. 3793.)

On dead wood. Brisbane.

Crowded, thin, flabelliform, more or less stipitate, silky, dingy ochre with darker bands, and (when dry) rugulose from base to margin, usually split into numerous lobes, the splitting extending to the stem; hymenium dingy ochre.

Stereum pusiolum, *Berk. & Curt.* Minutum, rufo-brunneum, flabelliforme, postice in stipitem brevissimum attenuatum; pileo convexo, subtiliter tomentoso, lineato-rugoso; hymenio lævi;

sporæ subglobosæ, 3–3·5 μ diam.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 330. (Type in Herb. Berk. Kew. n. 3762.)

On rootlets. Cuba.

Whole plant 1–2 lines high; stem spurious, often altogether obsolete. Substance very thin, contracting when dry, and becoming paler.

STEREUM CRENATUM, *Lév.* *S.* pileo coriaceo, flabelliformi, nudo, castaneo, zonis obscurioribus variegato, margine lobato acuto; hymenio carneo-rufo; stipite brevi, hirsuto, basi peltato-dilatato. —*Lév. in Ann. Sci. Nat.* sér. 3, i. p. 210.

On trunks. Java.

From 2–3 centim. high; pileus membranaceous, firm; margin lobed and sterile below. *S. pusillum*, Berk., differs in the naked, non-dilated stem and absence of zones on the pileus.

STEREUM FISSUM, *Berk.* Album; pileo primum spathulato, demum flabellato profunde fisso; stipitibus brevissimis e basi communi membranaceo oriundis; hymenio lævi; sporæ ellipsoideæ, 8–10 × 4–5 μ.—*Berk. in Hook. Kew Journ. Bot.* viii. p. 273. (Type in Herb. Berk.)

On dead twigs. Brazil; Ecuador.

White when recent, ochraceous when dry. Pilei about an inch long, at first spathulate or petaliform, smooth and even or with a few obscure raised lines, then expanded and flabellate, deeply fissured nearly to the base; stems short or obsolete, arising from a common membranaceous mycelium, which occurs in patches or spreads round the whole branch.

The habit is precisely that of *Cantharellus partitus*, Berk.; no species can be more distinct. Occasionally there is a tendency in the hymenium to become venose, but probably only from contraction in drying (*Berkeley.*)

STEREUM GLABRESCENS, *Berk. & Curt.* Pileo flabelliformi, zonato, castaneo, subtiliter velutino, glabrescente striatulo; margine pallidiore crenato-labato, postice in stipitem brevissimum lateralem angustato; hymenio concavo ochraceo; sporæ subglobosæ, 5 × 4 μ.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 330. (Type in Herb. Berk. n. 3757.)

On dead wood. Cuba.

From $\frac{2}{3}$–$1\frac{1}{2}$ inch high and broad, flabelliform from a narrow base, rough behind, with scattered aculeiform outgrowths.

STEREUM MYTILINUM, *Fr.* Pileo dimidiato, sessili, coriaceo, tomentoso, concentrice sulcato, margine glabro nigricante; hymenio carneo-glauco; sporæ ellipsoideæ, 7×4 μ.—*Fr. Epicr.* p. 548.—Thelephora badia, *Hook. Bot. Miscell.* ii. p. 162, pl. lxxxiv.

Brazil; New Granada.

From 3–5 inches long, about 4 inches broad, flabelliform, lobed, plane or depressed, strigose or coarsely velvety, sometimes becoming almost smooth. Allied to *Stereum lobatum.*

STEREUM OBLIQUUM, *Mont. & Berk.* Minimum, coriaceum; pileo verticali, elongato, flabelliformi, polito, glabro, subzonato, sub lente sericeo-striato, castaneo-badio; stipite e basi orbiculari oriente, erecto, laterali, velutino, cervino; hymenio definito, subcinereo, lineolato; sporæ globosæ, 4 μ.—*Mont. & Berk. in Hook. Lond. Journ. Bot.* iii. p. 334. (Type in Herb. Berk. n. 3752.)

Java; Brazil; New Zealand.

"Whole plant not exceeding $1\frac{1}{4}$ inch in height. Pileus thin, coriaceous, elongated, spathulato-flabelliform, of a chestnut-brown inclining to bay, obscurely zoned, shining, but under a lens finely seriato-striate; margin indistinctly fimbriate. Stem about $\frac{1}{2}$ inch high, not $\frac{1}{2}$ line thick, erect, springing from a membranous orbicular base, velvety, of a yellowish-fawn colour. Hymenium distinctly defined, often with a little raised border at the base, springing from the edge of the pileus, ochraceous with a cinereous tinge, subsetulose, distinctly though minutely marked with elongated sometimes branched lines.

"A very elegant species, which cannot be confounded with any described species. It resembles, perhaps, *Thelephora aurantiaca* more than any other fungus; but it is abundantly distinct." (*Berk. & Mont.*)

STEREUM PRINCEPS, *Jungh.* Maximum, crassum; pileis dimidiatis, horizontalibus, ferrugineo-fuscis, zonatis, glabris, margine albis, dein ambitu in lobos irregulares divisis; hymenio pallido-alutaceo, levi, dein cinerascente, basi papilloso.—*Junghuhn, Crypt. Jav.* 38.

On trunks. Java.

From 50–60 centim. high, sessile, fixed laterally; substance dry, coriaceous; immature specimens are blackish above, with a white margin. (*Junghuhn.*)

Stereum scytale, *Berk.* Rigido-coriaceum, ambienti-liberum; pileo lobato-zonato, radiatim ruguloso, subvelutino, spadiceo; contextu concolore; hymenio ochraceo umbrinoque; sporæ ellipsoideæ, $7 \times 4\ \mu$.—*Berk. in Hook. Kew Journ. Bot.* vi. p. 170. (Type in Herb. Berk. Kew. n. 3803.)

On dead wood. Himalayas; Brazil; Japan; Cuba.

Of a rigid coriaceous substance, but rather flexible; brittle when dry, and easily splitting from the base to the margin, effused, with the border reflected widely, 3 inches or more, zoned or grooved, marked with little longitudinal wrinkles, especially in the larger and thicker individuals, deep brown inclining to red, finely velvety or pubescent; substance brown like the pileus; hymenium ochraceous or tinged with umber, sometimes finely wrinkled towards the edge.

This species has many points in common with *S. rugosum*, but more especially with *S. subpileatum*. Though running over the matrix, and at first adnate with it, the border becomes widely reflected and lobed. Thick specimens approach the magnificent *S. princeps*. (*Berkeley*.)

Stereum spathulatum, *Berk.* *S.* pileo spathulato, postice hispidulo, antice glabrescente subtiliter lineato; stipite luteo, velutino, laterali cum pileo confluente; hymenio pallido, subzonato; sporæ globosæ, 5–6 μ diam.—*Berk. in Hook. Kew Journ. Bot.* viii. p. 274. (Type in Herb. Berk. Kew. n. 3759.)

On wood on the banks of the Rio Negro; Brazil.

Pileus $\frac{3}{4}$ inch long, $\frac{2}{3}$ inch broad, spathulate or subflabelliform, connate below, clothed behind with scattered bristles, which vanish in front, leaving, however, as their representatives fine raised lines, red-brown, with a pale margin; stem $\frac{1}{2}$–$\frac{3}{4}$ inch high, yellowish, velvety, hispid above, attached by a round disc; hymenium pale, ochraceous, with one or two dark zones, smooth.

Analogous to *Polyporus luteus*, of which it has very much the appearance.

Stereum subcruentatum, *Berk. & Curt.* *S.* pileo dimidiato, conchiformi, decurrente, albido, postice cruentato, zonato; hymenio levi, ochroleuco.—*Berk. & Curt. N. Pacific Expl.* n. 106.

On wood. Japan.

Pilei attached by a narrow base, about 1 inch long by $\frac{1}{2}$–$\frac{1}{3}$ inch broad.

STEREUM SPECTABILE, *Klotzsch.* Subauriforme, umbonato-sessile, papyraceo-coriaceum; pileo flabelliformi, profunde lobato, concentrice zonato, saturate cervino, badio-variegato, evanescenti-hirto, apice minutissime fimbriato, marginibus inflexis; hymenio levi, glabro, e fuscescente glauco.—*Klotzsch, Fung. orb. terr. circumnav. Meyen Coll.* p. 238, t. 5. f. 2.

On trunks. Manilla and Mauritius.

Pileus 2·5 centim. high, and broad at the apex.

STEREUM AFFINE, *Lév.* *S.* pileo reniformi vel flabellato nudo castaneo, zonis obscurioribus, margine acutissimo; hymenio glabro, rufo-carneo; stipite tenui, velutino, fulvo, peltato-dilatato.—*Lév. in Ann. Sci. Nat.* sér. 3, i. p. 210.

On trunks. Java; Sumatra.

From 2–4 centim. high; pileus membranaceous, very coriaceous, elastic, usually reniform.

Tulasne says that if the present species had a porous hymenium it would be an exact representation of *Polyporus affinis*: hence the specific name.

STEREUM CYPHELLOIDES, *Berk. & Curt.* Parvum, pallide ochraceum; pileo flabelliformi, subzonato, subtiliter depresso-tomentoso, rugoso-striato, in stipitem brevem spuriumve angustato; hymenio lævi, pallido; sporæ globosæ, 4 μ diam.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 331. (Type in Herb. Berk. n. 3761.)

On the ground amongst moss. Cuba.

Very thin, and contracting when dry. Largest specimen $\frac{1}{4}$ in. wide and 2 lines long.

STEREUM SPONGIOSUM, *Massee*, n. sp. *S.* pileo dimidiato, postice incrassato, umbrino vel cinnamomeo, spongioso-tomentoso, contextu umbrino; hymenio ochraceo, rimoso; sporæ ellipsoideæ, 6–7 × 4 μ.—Stereum Micheneri, *Berk. & Curt. in Grev.* i. p. 162 (in part). (Type in Herb. Berk. n. 3817 *a.*)

On slender twigs. Pennsylvania and S. Carolina.

Dimidiate, subreniform, from 1–3 inches across, growing from small twigs, often imbricate, very much incrassated at the base, where the larger specimens are $\frac{1}{2}$ inch thick or more. Substance spongy when dry.

STEREUM VERSICOLOR, *Fr.* Umbonato-sessile, submembranaceum; pileo postice subeffuso applanato villoso, zonis margine-

que glabrescentibus fuscis versicolore; hymenio levi, glabro, pallido; sporæ ellipsoideæ, 5 × 3 μ.—*Fr. Epicr.* p. 547.—Thelephora versicolor, *Swartz, Fl. Ind. Occ.* iii. p. 1933.—*Exs.*: Ellis, N. Amer. Fung. 514; Rabenh.-Wint. Eur. Fung. 2934; Rav. Fung. Amer. 220; Fungi Cubenses Wrightiani, 396.

On trunks. Xalapa, Mexico; Cuba; Surinam; Jamaica; United States; S. Africa; W. Australia.

Resembling superficially some forms of *Hymenochæte Kunzeii*. Thin, flabellate, with raised concentric zones, strigose, variously coloured or whitish, sometimes becoming smooth and polished, brown; sometimes centrally attached infundibuliform, or with the margin only free.

Stereum vespilloneum, *Berk.* Tenue, flabelliforme, vertice parvo orbiculari affixo; pileo badio, rufo zonato, velutino; hymenio badio, margine sterile pallido; sporæ ellipticæ, 7 × 5 μ.—*Berk. in Linn. Soc. Journ.* (*Bot.*) xvi. p. 44. (Type in Herb. Kew.)

Aru Is., N. Guinea (' *Challenger* ' *Expedition*).

Pileus $2\frac{1}{2}$–3 in. across, 2 in. long, then repeatedly zoned; velvety, with a few dark, nearly smooth interstices.

Stereum villosum, *Lév.* *S.* pileis submembranaceis, cuneiformibus, zonatis, fuscis, in stipitem brevem lateralem discoideum attenuatis, setis ramosis hirtis; hymenio glabro, fusco, cinerascente micaceo; sporæ globosæ, 5–6 μ.—*Lév. in Ann. Sci. Nat.* sér. 3, i. p. 212.—Thelephora (Apus) erinacea, *Jungh.* (herb. Lugd.-Batav.). Thelephora nov., *S. Zippelius* (ibidem).

On trunks. Java. (Specimen from Léveillé, in Herb. Berk. Kew.)

Closely resembling *S. nigricans*, but distinguished by the cuneiform pileus, continued into a short stem slightly dilated at the base, and the powdered hymenium.

Stereum vellereum, *Berk.* Resupinato-ambiens, margine demum late libero lobato, sursum stupeo-strigosum, versus marginem zonatum; hymenio ochraceo, levi; sporæ subglobosæ, 4–5 μ diam.—*Berk. in Hook. f. Fl. N. Zeal.* p. 183. (Type in Herb. Berk. n. 3780.)

On branches. New Zealand; Australia.

Usually growing on small branches, and then resembling *Hymenochæte tabacina* in habit, with broad, free, more or less

lobed wings; substance thin; when growing on thick branches or logs often imbricated and attenuated at the base; pilei 1–2 inches across, densely strigose. Resembling in colour and habit *Stereum hirsutum*, but thinner and with very different spores.

STEREUM PUSILLUM, *Berk.* Cartilagineo-coriaceum; pileo flabellari, nitide umbrino-rufo, azono, sericeo-striato, glabro; margine acutissimo, tenui, lobato; stipite curto, sublaterali erecto; hymenio pallido, levi, glabro; sporæ subglobosæ, 3–4 μ diam.—*Berk. Fung. Brit. Mus., in Ann. Nat. Hist.* x. (1842) p. 381. (Type in Herb. Berk. n. 3751.)

On wood. Ceylon; Tasmania.

Stem $\frac{1}{2}$ inch high; pileus $\frac{2}{3}$ inch high, thin. Related to *Stereum elegans*, but distinguished by its smaller spores and flabelliform pileus.

STEREUM STRIATUM, *Fr.* Coriaceum; pileo effuso-reflexo, undulato, rugoso-striato, subtomentoso, fusco-ferrugineo, intus filamentoso pallidiore; hymenio cinereo-albido, lævi, pubente; sporæ subglobosæ, 5-6 μ diam.—*Fr. Hym. Eur.* p. 641.—Stereum scriblitum, *Berk. & Cooke in Grev.* vii. p. 102. Stereum Schraderi, *Thuem.*

On pine and other wood. Europe; Canada; U. States; Brazil; Australia.

Thin, wholly adnate or attached by a narrow base, and flabelliform, with intermediate stages.

STEREUM RIGIDULUM, *Speg.* *S.* pileis tenuibus, pergameneo-membranaceis, rigidulis, liberis 1·5 cm. diam. trans., 0·7–1 cm. diam. ant. post., dimidiato cordatis vel cuneato-obovatis, gregariis sed rarius confluentibus vel connatis, postice dilatatulo-adnatis, non vel vix effusis, superne adpresse villoso-hirsutis, non vel grosse obsoleteque zonatis, deorsum fusco- vel subtestaceo-canescentibus, ambitu pallidioribus, margine acutis repandulis vel vix lobulatis; hymenio plano, levi, purpurascente vel livido, azono, marginem versus pallidiore, in juventute carneo-pruinuloso.—*Speg. Fungi Fueg.* n. 82.

On fallen beech-branches. Port Cook; Staten Island; Tierra del Fuego.

STEREUM PULVERULENTUM, *Massee.* *S.* pileo coriaceo, reflexo, suborbiculari, postice attenuato depresso tomentoso ferrugineo-

fusco, zonis tenuissimis notato; margine tenui, undulato; hymenio inæquabili, fulvo, pulverulento, contextu concolore.—Thelephora (Stereum) pulverulenta, *Lév. in Ann. Sci. Nat.* sér. 3, v. p. 149.

On trunks. Cape of Good Hope.

Pilei membranaceous, flexible, flattened and depressed behind; hymenium covered with brown powder.

STEREUM MOLLE, *Massee*. *S.* pileo coriaceo, orbiculari, sessili, spongioso-velutino, zonato, pallidè fulvo; hymenio lævi, purpurascente; sporæ subglobosæ, 6×4–$5\,\mu$.—Thelephora (Stereum) mollis, *Lév. in Ann. Sci. Nat.* sér. 3, v. p. 147.

On trunks. New York; S. Carolina; Nilghiris. (Specimen from Léveillé in Herb. Berk. Kew.)

Coriaceous, flexible, 2–5 centim. broad, attenuated behind, zoned, soft and spongy above from the pubescence; margin entire, undulate; hymenium pale purple, somewhat resembling *S. hirsutum*, but thinner.

STEREUM LEICHARDTIANUM, *Massee*. *S.* pileo coriaceo, applanato, postice attenuato zonato spongioso-velutino fulvo; margine tenui, integro, postice inflexo; hymenio glaberrimo, pallide flavo.—Thelephora (Stereum) Leichardtiana, *Lév. in Ann. Sci. Nat.* sér. 3, v. p. 148.

On trunks. S. Australia.

A very constant species; pileus tomentose, zoned; hymenium pale yellow.

STEREUM LOBATUM, *Fr.* Umbonato-sessile, coriaceum; pileo rigido, tomentoso, zonis marginique glabrescentibus versicolore; hymenio levi, glabro; sporæ subglobosæ, 5–6 μ diam.—*Fr. Epicr.* 547.—Stereum luteo-badium, *Fr. Epicr.* p. 547. Stereum Boryanum, *Fr. Epicr.* p. 547. Stereum Ostrea, *Nees in Nov. Act. Nat. Cur.* xiii. t. 2, p. 13. Stereum Sprucei, *Berk. in Journ. Linn. Soc. (Bot.)* x. p. 331. Stereum perlatum, *Berk. in Hook. Journ.* iv. 1842, p. 153.

Australia; Tasmania; N. Zealand; Africa; Mauritius; Madagascar; Cuba; U. States (N. Orleans); Venezuela; Brazil; India; Ceylon; Bourbon; Malay Peninsula; Java; Mexico; Peru; Philippines; Guadaloupe; Malacca; New Guinea; Surinam; Seychelles.

A careful examination of authentic specimens of all the above species, except *S. Ostrea* (where I have accepted the determination of the Rev. M. J. Berkeley), shows that the species cannot be separated from *S. lobatum*. In the last-named species the thickness of the pileus, rugosity, and relative amount of villosity ranges over all the characters of the species quoted as synonymous. The hymenium varies from bright ochraceous through duller shades to cinereous.

Pileus 3–5 inches across, often more or less lobed, usually thin, but in some specimens thick and rigid; colour reddish cinnamon or brownish, with darker zones more or less pronounced.

Stereum involutum, *Klotzsch*. Coriaceum; pileis cæspitosis, imbricato-concrescentibus, auriformibus, longitudinaliter striatis, rugosis, azonis, basi in stipitem lateralem nigrum attenuatis; hymenio levi, nudo, violaceo-purpureo; sporæ globosæ, 4 μ diam.—*Klotzsch in Linnæa*, vii. p. 499; *Fr. Epicr.* p. 546. (Specimen from Klotzsch in Herb. Berk. n. 3758.)

On trunks. Mauritius; Borneo; New Guinea; Malay Peninsula; Nilghiris; Queensland; Australia.

Pilei 1–2 inches long, 1 inch or more broad, sometimes subflabelliform, brownish with olive shades, becoming blackish towards the base; substance thin, rigid when dry; surface densely tomentose or velvety, becoming smooth; hymenium sometimes ochraceous-brown.

Stereum Galeottii, *Berk.* Umbonato-sessile, parvum, convexum, rigidum; pileo cervino, velutino-tomentoso, crebrissime badio-zonato; zonis hic illic glabris, nitentibus; hymenio cinereo-alutaceo; sporæ globosæ, 5 μ diam.—*Berk. in Hook. Kew Journ. Bot.* iii. p. 15. (Type in Herb. Kew.)

On wood. Mexico; Brazil; Vera Cruz.

Pileus $1\frac{1}{2}$ inch broad, 1 inch long, subflabelliform, umbonato-sessile, mostly convex above, slightly undulated, thin but rigid, fawn-coloured, clothed with velvety down; repeatedly zoned; zones mostly very close and narrow, frequently forming bay-brown fasciæ; smooth and shining, alternating with paler. Hymenium tan-coloured, with a cinereous tinge. Undoubtedly nearly allied to *Stereum lobatum*, Kunze, but a much smaller and neater species, remarkable for its closely-zoned pileus. (*Berkeley.*)

STEREUM GLABRUM, *Massee*. *S.* pileo coriaceo, nudo, fusco, e margine ad basim sensim attenuato subpedicellato; hymenio luteo, glaberrimo.—Thelephora (Stereum) glabra, *Lév. in Ann. Sci. Nat.* sér. 3, v. p. 147.

On trunks. Java.

Membranaceous, coriaceous, attached by a minute central stem-like base. Hymenium very smooth, ochraceous; pileus longitudinally striate when dry.

III. *Pileus dimidiatus, sessilis, vel e resupinato effuso-reflexus, marginatus.*

STEREUM MEMBRANACEUM, *Fr.* Umbonato-sessile, subpapyraceum; pileo dimidiato, explanato, velutino, unicolore, umbrino; hymenio lævi, glabro, e violaceo fusco-purpureo; sporæ ellipsoideæ, 6 × 4 μ.—*Fr. Epicr.* p. 547.—*Exs.*: Fung. Cub. Wrightiani, 398.

On wood. United States; Cuba; Mexico; British Guiana.

Pileus 2–3 inches across, coarsely velvety, often spongy towards the base owing to the quantity of tomentum, indistinctly zoned.

STEREUM ATRO-ZONATUM, *Speg.* *S.* pileis dimidiato-reniformibus, crispulis, subimbricatis, coriaceis, sordide albo-griseis, lanuginosis, duabus zonis, una marginem, altera basim versus depressis atris, levibus, subnitentibus ornatis; hymenio levi, obscure purpureo-cinnabarino.—*Speg. Fung. Argent.* i. p. 166.

On dead trunks. Argentine Republic.

Pilei 1–2 centim. high, 5–7 centim. broad, ½–1 millim. thick. A beautiful and distinct species.

STEREUM BELLUM, *Massee.* Imbricatum, rigidum, pulchre fusco-cinereo fulvoque zonatum, sericeum, subtus leve, aurantiacum; sporæ globosæ, 3–4 μ diam.—Thelephora bella, *Kunze in Flora*, 1830, p. 370.—*Exs.*: Crypt. Lusit. 24.

On decayed stems of *Laurus*. Madeira.

Closely resembling *S. versicolor*. The margin often covered with small pilei, attached by a narrow base, and appearing proliferous.

STEREUM BICOLOR, *Fr.* Submembranaceum, molle; pileo conchato-reflexo, azono, e villoso glabrescente, spadiceo; hymenio

tenui, glabro, albo; sporæ subglobosæ, 8–9 μ diam.—*Fr. Epicr.* p. 349; *Hym. Eur.* p. 640; *Icones*, t. 197. f. 2.—Thelephora bicolor, *Pers. Syn.* p. 568.—*Exs.*: Rav. Fung. Car. 33; Rav. Fung. Amer. 9; Thuem. Myc. Univ. 1704; Ellis, N. Amer. Fung. 1207.

On trunks, &c. N. Europe; U. States; Canada; Cuba; New Guinea; Darjeeling and Nilghiris; Somerset East, Africa.

With the general habit and appearance of *S. complicatum*, but distinguished at once by the globose spores.

Stereum bizonatum, *Berk. & Curt.* Longitudinaliter effusum, adnatum, utrinque reflexum, pallidum, tomentosum, bizonatum; hymenio e rufo fusco-purpureo, margine pallido; sporæ globosæ, 5 μ diam.—*Berk. & Curt. in Grev.* i. p. 163. (Type in Herb. Berk. 3789.)

On branches. Lower Carolina.

"Running for several inches along sticks, replaced on either side, entire or lobed, pale umber, minutely tomentose, with about two zones; hymenium rufous in the younger parts, brown in the centre, extreme edge nearly white, next to which is a rufous zone." (*Berkeley.*)

Some of the type specimens are very thin, with the margin only free and lobed, strigose, ochraceous, zones indistinct; hymenium dirty ochraceous tinged with lilac or dingy purple.

Stereum concolor, *Jungh.* Imbricatum, tenue, coriaceo-chartaceum; pileis dimidiatis, e rufo lutescentibus, concoloribus, subtilissime innato-velutinis, zonatis; hymenio lævissimo, alutaceo-expallente.—*Jungh. Crypt. Jav.* p. 38.

Java.

Resembles *S. ostrea*, differing in the bright-coloured hymenium, at first white, then alutaceous, and the smooth or minutely velvety pileus.

Stereum complicatum, *Fr.* Resupinatum, liberum, pendulum, papyraceum; pileo striato fulvo-alutaceo, margine crispato lobato inflexo; hymenio lævi, glabro, pallido; sporæ cylindraceo-ellipsoideæ, utrinque obtusæ, 7–1 × 4 μ.—*Fr. Epicr.* p. 548. (Specimen from Fries in Herb. Berk. n. 3782.)—*Exs.*: Rab.-Winter, Fung. Eur. 3029; Fung. Cub. Wrightiani, 399; Rav. Fung. Amer. 117 & 448; Thuem. Myc. Univ. 1404; Ellis, N. Amer. Fung. 324; Rav. Fung. Car. 30.

On branches. United States; Canada; Cuba; Brazil.

A very beautiful species; pileus almost glabrous except towards the base, striate, brownish or ochraceous, often more or less zoned, thin, generally much crisped, more or less imbricate, and attached by a broad base behind, or subflabelliform and narrow attachment. Habit of *Stereum hirsutum*, but not strigose, much thinner, and with very different spores.

STEREUM CINERASCENS, *Massee*. Resupinato-effusum. In perfectioribus, pileis dimidiatis confluentibus, strigoso-zonatis, unicoloribus, cinereo-albidis, uncialibus, limbo tenuiore minus strigoso. Hymenio e cinereo subfuligineo-purpurascenti, siccitate præsertim, ubi resupinatim effusum est, rimoso; sporæ ellipsoideæ, 7×5 μ.—Thelephora cinerascens, *Schw. Syn. Fung. N. Amer.* 651. (Specimen from Schweinitz in Herb. Berk.)

On half-dead trunks of *Morus albus*. United States.

Broadly effused, thin, coriaceous; well characterized by the dark-grey hymenium and upturned strigose margin.

STEREUM DESOLATIONIS, *Speg.* Pileis effuso-reflexis, conchatis, latiusculis, 3–5 cm. lat., 2 cm. long., tenuibus, membranaceo-pergameneis, rigidis, superne primo villosulis, concentrice obsolete zonatis, sordide albo-canescentibus, per ætatem subglabratis ac pallide subtestaceis, margine acutis, non vel vix repandulis, hic inde minute fissis vel subfimbriatis; hymenio lutescenti-purpurascente, azono, glabro vel basim versus subpubescente.—*Speg. Fung. Fueg.* n. 79.

On rotten fallen trunks. Tierra del Fuego.

STEREUM EFFUSUM, *Berk.* Pallidum; margine inflexo, lacerato-lobato, lineato, pulverulento; hymenio lineato; sporæ cylindrico-ellipsoideæ, 7–8 $\times$ 3 μ.—*Berk. in Journ. Linn. Soc. (Bot.)* xvi. p. 44. (Type in Herb. Kew.)

Melammon Island (‘*Challenger*’ *Exp.*).

Pileus by confluence 3 in. wide; pileus sometimes scarcely lineate, and then more pulverulent. (*Berkeley.*)

STEREUM ENDOCROCINUM, *Berk.* Pileo crasso, suberoso, postice decurrente, antice reflexo, profunde concentrice sulcato, velutino hispido intus aurantiaco; hymenio ochraceo-fusco; sporæ globosæ, 8–10 μ diam.—*Berk. in Hook. Kew Journ. Bot.* vi. p. 169. (Type in Herb. Berk. Kew. n. 3809.)

On dead branches. Yangma Valley, East Nepal (*Dr. Hooker*).

Corky, 2 lines thick. Pileus 2 inches across, decurrent behind, so as to form an irregular cap, deeply sulcate above, coarsely velvety; margin obtuse; substance deep orange or brick-red, clothed, where attached, with spongy pubescence of the same colour. Hymenium even, ochraceous, tinged with brown. A very curious species, calling to mind *Hydnum aurantiacum* by the colour of its mycelium. (*Berkeley.*)

Thick, imbricated, densely velvety, pale ferruginous when dry, inside reddish, hymenium cinnamon.

Stereum fulvum, *Massee.* Pileo coriaceo, membranaceo, applanato, sessili, zonato-sulcato, hirsuto, fulvo; margine tenui, pallidiore; hymenio rugoso, concentrice sulcato, nudo, postice fulvo, antice dilutiore.—Thelephora (Stereum) fulva, *Lév. in Ann. Sci. Nat.* sér. 3, v. p. 149.

On trunks. Cape of Good Hope.

Pileus 2–4 cm. across, thin towards the margin and flexible; the depressed zones showing on the pileus as elevations.

Stereum fasciatum, *Fr.* Coriaceum; pileis cæspitosis planis villosis griseo-cinereis, fasciis spadiceis nitentibus zonatis, basi attenuatis substipitatis; hymenio lævi, glabro, testaceo, pallido; sporæ subglobosæ, 5–6 vel $5 \times 6\ \mu$.—*Fr. Epicr.* p. 546.—Thelephora fasciata, *Schw. Car.* n. 1011. (Specimen from Schweinitz in Herb. Berk.)—*Exs.*: Rav. Fung. Amer. 721; Fungi Cub. Wrightiani, 397; Ellis, N. Amer. Fung. 18; Rav. F. Car. 28.

On trunks. United States; Cuba; Jamaica; Mexico; St. Domingo; Canada; Japan; New Zealand; Madeira; Madagascar.

Thin, strigose, whitish, or with brown or almost black narrow zones; hymenium ochraceous, with sometimes reddish or lilac tints.

Stereum gausapatum, *Fr.* Cæspitoso-connatum, sessile; pileis suberoso-mollibus, conchatis, fibroso-strigosis, fusco-pallescentibus; margine concolore, integro, undulato-plicato; hymenio radiato-rugoso, glabro, obscuriore; sporæ cylindraceo-ellipsoideæ, $10 \times 5\ \mu$.—*Fr. Hym. Eur.* 638.—Thelephora gausapata, *Fr. Elench.* p. 171.—*Exs.*: Rav. Fung. Amer. 447.

On trunks. France; United States.

Tufted or fasciculate, pilei laciniate, towards the base concentrically zoned, and rugose in a radiate manner from the base.

Stereum hirsutum, *Fr.* Coriaceum, rigens; pileo effuso reflexoque, strigoso-hirsuto, subzonato, pallescente; margine obtusiusculo, luteo; hymenio levi, glabro, nudo, exsucco, lutescente varioque colore; sporæ globosæ, 5 μ diam.—*Fr. Epicr.* p. 549; *Fr. Hym. Eur.* p. 639; *Hussey*, i. t. 58; *Berk. Outl.* t. 17.—Thelephora hirsutum, *Willd. Ber.* p. 397; *Syst. Myc.* i. p. 439; *Pers. Syn.* p. 570. Auricularia reflexa, *Bull.* t. 274; *Sow. Eng. Fung.* t. 27; *Fl. Dan.* t. 1199.—*Exs.*: Rab. Fung. Eur. 1069, 1109, & 1806; Roum. Fung. Gall. 704, 831, & 3305; Oudemans, Fung. Neerl. 238; Syd. Myc. March. 312; Ellis, N. Amer. Fung. 1204; Klotzsch, Herb. Myc. (Rab.), 211; Berk. Brit. Fung. 146; Cooke, Fung. Brit. 307, ed. 2, 108; Westend. Cr. Belg. 766; P. Karst. F. Fenn. 129, 433; Thuem. Fung. Austr. 10, 332, & 821; Sacc. Myc. Ven. 32; Fuckel, Fung. Rhen. 1321; Desm. Cr. Fr. ser. i. 116; Ayres, Myc. Brit. 53.

On trunks and branches. Britain; Europe; United States; British N. America; Vancouver Island; Mexico; Ecuador; Cuba; Venezuela; Bombay; Sikkim Himalayas; Australia; Tasmania; New Zealand; Chatham Island.

Very variable in form, sometimes adnate and very broadly effused, with the extreme margin only free: this form is most common on logs and trunks; when growing on smaller branches there is often a broad free margin; the pilei imbricate, and hymenium inferior; often commences as small roundish patches, many of which become confluent. Pileus coarsely strigose, dirty ochraceous, soon becoming pale; hymenium most frequently clear ochre, often with varying shades of grey or pale pink. The globose spores separate this from allied species, as *S. complicatum*, &c.

Var. subcostatum; hymenio nudo, exsucco, vage costato lutescenti-albo, basim versus læte incarnato seu gilvo.—Stereum subcostatum, *P. Karst. in Hedw.* 1881, p. 178.

Britain; Lapland.

Var. cristulatum; pileo hirto griseo, hymenio carneo.—*Quelet, Fung. Jura*, iii. t. i. f. 15.

France.

Stereum illudens, *Berk.* Coriaceum, subrigidum; pileo effuso reflexoque, zonato, radiato-plicato, hirsuto, spadiceo; hymênio lævi, glabro, corneo, rufo; sporæ ellipsoideæ, 6–7 × 4 μ.—*Berk. in*

Hook. Journ. Bot. iv. p. 59. (Type in Herb. Berk. 3776.)—Stereum phalenarum, *Kalchbr. MS.*

On wood and sticks. Tasmania; Australia; New Zealand; Venezuela.

Pileus effused behind, with the margin reflected, about 1 inch long and several inches in breadth, from the confluence of many individuals. Coriaceous, rather rigid, zoned, clothed with a short hairy pile, often plicate in young specimens, of a rich brown, becoming grey in the older parts, or when the outer coat has vanished dark brown. Hymenium cracked, smooth, reddish brown, with frequently a flesh-coloured bloom.

This species is intermediate between *S. purpureum* and *S. spadiceum*, but is distinct from either. The hymenium is nearly of the same colour with that of *S. quercinum*, with a beautiful flesh-coloured bloom. (*Berkeley.*)

Readily recognized by the presence of numerous projecting hairs on the hymenium resembling miniature bottle-brushes; often barren. Not a good *Stereum.*

Stereum Kalchbrenneri, *Massee.* Sessile, membranaceum; pileis postice coarctatis, confluentibus, planiusculis, villosis, zonatis, canescentibus; hymenio lævi, glabro, albo-lilacino; sporæ ellipsoideæ, 7×4–5 μ.—Stereum anœmum, *Kalchbrenner in Flora*, 1876, p. 424.—*Exs.*: Thuem. Myc. Univ. 1108. (Specimen from Kalchbrenner in Herb. Berk.)

On old trunks. S. Africa.

Related to *S. hirsutum*, but differing in the thinner texture, closely-zoned pileus, and lilac hymenium.

Stereum lugubris, *Cooke.* Coriaceum, rigidum; pileo effuso reflexoque, tomentoso, zonato, cinereo-pallescente, zonis obscurioribus, margine subacuto, pallido; hymenio subpapilloso, glabro, nudo, atro.—*Cooke, Grev.* xii. p. 85.

On logs. New Zealand.

A very distinct species by its black obtusely papillate hymenium. Pilei about an inch deep, often densely imbricated, and extending laterally several inches.

Stereum leucophæum, *Lév.* Sessile, reflexum; pileo semiorbiculari, plano, coriaceo, flexili, zonato, subtomento, margine sinuato acuto; hymenio glabro, albo, tandem rimoso.—*Lév. in Ann. Sci. Nat.* sér. 3, i. p. 212.

On trunks. Spain.

Allied to *S. bicolor*, differing in the zoned, deeper-coloured pileus, which is minutely tomentose and pliant like leather.

Stereum aterrimum, *Cooke.* Rigido-coriaceum, ambienti-liberum, nigrum; pileo semicirculari, sublobato flexuosoque, concentrice sulcato-zonato, glabrescente, contextu nigro-fusco, nigro-purpureo vergente; hymenio glabro, atro-fuligineo, pruinoso, demum nigrescente; sporæ ellipsoideæ, 6×4 μ.—*Cooke, Grev.* xiii. p. 3. (Type in Herb. Kew.)

On rotten wood in open dry ground. Goping, Malay Peninsula.

Allied to *S. princeps* and *S. scytale.*

Pileus 2–3 inches broad, very rigid, but fragile, 1 mm. thick and upwards. Substance purplish black. The pilei are often more or less connate at the base in a thick irregular common stem. (*Cooke.*)

Stereum Micheneri, *Berk. & Curt.* Pileo coriaceo, umbrino vel cinnamomeo, spongioso-tomentoso, convexo, lateraliter connato vel libero; hymenio lævi, ochraceo, nitido; sporæ ellipsoideæ, utrinque obtusæ, 6×3–4 μ.—Stereum Micheneri, *Berk. & Curt. in Grev.* i. p. 162 (in part). (Type in Herb. Berk. n. 3817.)

On wood. New England.

Consisting of semiorbicular plants attached by a central point and soon becoming confluent; pileus tomentose, bright brown or clear cinnamon; hymenium pale ochraceous, polished. The edge of the pileus is thin and usually incurved.

Stereum nigricans, *Lév.* Reflexum, membranaceum; pileo reniformi, plano, zonato, fuligineo, setis ramosis hirto; hymenio glabro, concentrice sulcato, castaneo.—*Lév. in Ann. Sci. Nat.* sér. 3, i. p. 212. Thelephora (Stereum) nigricans, *Lév. in Voy. Bonite*, pl. 139. f. 5.

On trunks. Cochin-China.

Pileus almost reniform, 5–6 cm. broad, margin undulated, zoned, and covered with black hairs; branched as in *Trametes hydnoides*, but less rigid. Hymenium dark brown, with the depressed zones of the pileus showing on its surface.

Stereum Nicaraguæ, *Berk. & Curt.* Pileo dimidiato, rugoso, inæquabili, villoso, zonato, candido; contextu umbrino; hymenio

cinereo; margine tenui, umbrino; sporæ ellipsoideæ, $4 \times 3\ \mu$.—*Fung. N. Pac. Expl.* n. 105. (Type in Herb. Berk. n. 3820.)

On trunks. Nicaragua.

Rather soft and pliant; margin of pileus plicate and apparently imbricated from the margins of the zones being free and partly overlapping like pleats.

Stereum ochraceo-flavum, *Massee.* Effuso-reflexum, subcoriaceum, strigoso-hirsutum subfasciatum; hymenio læte ochraceo, pallescente; sporæ ellipsoideæ, $7 \times 5\ \mu$.—Thelephora ochraceo-flava, *Schw. Syn. N. Amer. Fung.* n. 649.—*Exs.*: Rav. F. Amer. 787; Rav. Fung. Car. 31; Ellis, N. Amer. Fung. 17; Thuem. Myc. Univ. 10. (Specimen from Schweinitz in Herb. Berk.)

On wood. United States.

Sometimes entirely aduate, margin generally broadly free and upturned, densely strigose; when on a large branch forming by confluence broadly extended patches, on small branches and twigs the individuals are usually imbricate; hymenium bright ochre, almost orange when fresh, becoming paler.

Stereum ochroleucum, *Fr.* *S.* pileo coriaceo, crassiusculo, libero, expanso, flaccido, sericeo, zonato, cano; hymenio lævi, glabro, lutescente, sicco rimoso; sporæ ellipsoideæ vel subglobosæ, 8×6–$7\ \mu$.—*Fr. Hym. Eur.* p. 639.—Corticium ochroleucum, *Fr. Epicr.* p. 557. (Specimen from Fries in Herb. Berk. Kew. n. 3948.)

On wood and bark. Britain; Europe; N. America; Cuba; Venezuela; Tasmania; India.

Ochraceous, villous or strigose, when old often becoming smooth; sometimes broadly effused and entirely adnate, in others the margin only free and upturned, in others again quite free and attached by a narrow base. It is not unusual to meet with all transitions from entirely adnate to the flabelliform condition on the same trunk. Hymenium pale ochre, smooth, cracked, especially when dry; the latter character separates it from *Stereum hirsutum*, and also from *Corticium*, which the adnate form resembles.

Stereum pulchrum, *Cooke.* *S.* pileo reniformi, tenui, coriaceo, zonato, fusco-ferrugineo, adpresse sericeo; margine undu-

lato; hymenio glabro, cinnamomeo; sporæ ellipsoideæ, $7 \times 3\ \mu$.—(Thelephora pulchra, *Schweinitz, MS. and specimen in Herb. Berk.*) Stereum lætum, *Berk. & Curt. in Journ. Acad. Nat. Sci.*, April 1853, p. 279 (pro parte).

On rotten wood. Surinam.

Superficially almost exactly resembling *Hymenochæte læta*, Berk., but a true *Stereum*. Pileus 1½–2 in. long, one inch or less broad. Has been confused by Berkeley with *Hymenochæte læta*, Berk., and *H. rheicolor*, Mont.

Stereum percome, *Berk. & Broome*. E resupinato reflexum, papyraceum; pileo zonato, spongioso, hispido; margine tenuissimo; hymenio concentrice sulcato, cervino-rufo, velutino; sporæ ellipsoideæ, $6 \times 4\ \mu$.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 65. (Type in Herb. Berk. 3819.)

On dead wood. Central Province, Ceylon; Cape.

Thin, often broadly effused owing to several plants becoming confluent; at first orbicular with a delicate white margin; fixed by all the under surface except the free upturned strigose margin; hymenium minutely velvety, cinnamon. The substratum became reddish when treated with potassic hydrate.

Stereum pannosum, *Cooke*. *S.* pileo coriaceo, rigido, effuso-reflexo, cinereo, subzonato, hirsuto; hymenio nudo, glabro, radiato-rimoso laceratove, cinereo, demum pruinoso; sporæ ellipsoideæ, $5\text{–}6 \times 3\text{–}4\ \mu$.—*Cooke, Grev.* viii. p. 56.

On bark of trees. N. Zealand.

Effused for three or four inches, with the margin torn and split, separable, slightly reflexed above and villous; entirely cinereous.

Stereum pictum, *Berk. in herb.* *S.* pileo coriaceo-membranaceo, umbonato-sessili, vel postice effuso, cinereo, villoso, zonis margineque glabrescentibus badiis; hymenio pallido-ochraceo dein cinerascente; sporæ ellipsoideæ, $7 \times 5\ \mu$.

On wood. Brazil.

A large and fine species. Pileus 3–4 inches long, thin, rigid when dry, densely velvety, with margin and somewhat crowded brown zones becoming glabrous. Allied to *S. versicolor*, but readily recognized by its larger size, and more especially by its much larger spores.

STEREUM PURPUREUM, *Pers.* Coriaceo-molle; pileo effuso-reflexo, subimbricato, zonato, villoso-tomentoso, pallido albidove; hymenio nudo, lævi, glabro, purpurascente; sporæ ellipsoideæ, 7–8 × 4 μ.—*Pers. Obs. Myc.* ii. p. 92; *Fr. Hym. Eur.* p. 639.—Thelephora purpurea, *Hussey*, i. t. 20; *Fr. Syst. Myc.* i. p. 440. Auricularia reflexa, *Bull.* t. 483. Auricularia persistens, *Sow. Eng. Fung.* t. 388.—*Exs.*: Westendorp, Herb. Cr. Belg. 431; Ellis & Everh. N. Amer. Fung. ser. 2, 1714; Thuem. Fung. Austr. 820, 920; Fuckel, Fung. Rhen. 1322; P. Karst. Fung. Fenn. 128; Cooke, Brit. Fung. ed. 2, 12; Roum. Fung. Gall. 2807; Klotzsch, Herb. Myc. (Rab.), 504; Syd. Myc. March. 916; Cooke, Fung. Brit. 527; Ellis, N. Amer. Fung. 323; Berk. Brit. Fung. 147; Desm. Cr. Fr. ser. i. 117, 414.

On trunks, branches, &c. Britain; Europe; United States; Vancouver Island; Australia; Tasmania; Darjeeling.

Very variable in size and habit. Often broadly adnate with the extreme margin only free and upturned, or broadly reflexed and imbricate, when the individuals are frequently small, not more than ½–1 inch across, but sometimes much larger, rather thin, rigid and incurved when dry. Pileus silky, tomentose, not coarsely strigose as in *S. hirsutum*, and with often one or two narrow blackish zones near the margin. Hymenium more or less purple, becoming sordid ochre when dry.

Var. LILACINUM; minus, subtus lilacinum.—*Fr. Hym. Eur.* p. 639.—Thelephora lilacina, *Pers. Syn.* p. 572. Elvela lilacina, *Batsch, Fung.* f. 131.

On fir-trunks. Europe.

Var. VENOSUM; pileo conchato, effuso-reflexo, tomentoso, lacteo; hymenio parce plicato, lacteo-stramineo. — Stereum vinosum, *Quelet in Assoc. Fr.* 1882, t. 11. f. 16; *Enchirid.* p. 204.

France.

In all probability not even a good var., but only a bleached form of *S. purpureum*.

STEREUM RETIRUGUM, *Cooke.* Coriaceo-membranaceum, murinum; pileo effuso e cupulari explanato, confluente, marginato, ambitu pallide fimbriato, sublibero; hymenio subvelutino, reticulato-venoso, murinaceo; sporæ subglobosæ, 8 × 7 μ.—*Cooke in Proc. Roy. Soc. Ed.* 1882, p. 456, *and in Grev.* (Type in Herb. Kew.)

On wood. Island of Socotra.

Stereum rugosiusculum, *Berk. & Curt.* *S.* pileo dimidiato, cinnamomeo, plicato, subtiliter rugoso; margine incurvo; hymenio purpureo-fusco; sporæ ellipsoideæ, 6×4 μ.—*Berk. & Curt. in Grev.* i. p. 162.—(Type in Herb. Berk. n. 3818.)

New England. On wood.

About $\frac{3}{4}$ inch long, umber; pileus lobed and plicate, with an incurved margin, minutely wrinkled as if from contraction in drying, tomentose, becoming smooth; hymenium even, dark brown. Probably of a soft coriaceous consistence when fresh. (*Berkeley, l. c.*)

In the original specific diagnosis by Berkeley the pileus is described as "umbrino," and the hymenium as "fusco," but the type specimen in Berkeley's Herbarium is now coloured as described above. The margin of the pileus is generally more or less strigose or filamentous.

Stereum rameale, *Massee.* Ambiens, coffeicolor, confluens, margine late reflexo, extus zonata strigosa; hymenio glabro; sporæ subglobosæ, 5 μ.—Hymenochæte ramealis, *Berk. in Journ. Linn. Soc. (Bot.)* xiv. p. 68.

On branches of living shrubs. Ceylon.

Running down the stems for several inches; margin on either side broadly reflexed.

Stereum radicale, *Massee.* *S.* pileo crassiusculo, intus albo, reflexo, plano, strigoso, albido-fulvo; hymenio glabro, rimoso, pallide fulvo demum fusco; margine sterili, tomentoso; sporæ ellipsoideæ, 7×5 μ.—Corticium radicale, *Berk. in Hook. Journ. Bot.* iv. p. 59. (Type in Herb. Berk.)

At the base of living shrubs. New South Wales.

Pileus $\frac{3}{4}$ inch long, $1\frac{3}{4}$ inch broad, effused at the base and surrounding the matrix, broadly reflected above, clothed with fasciculate tawny, strigose hairs; substance rather thick, white, margin slightly lobed, thin. Hymenium minutely cracked, tawny when fresh, pale brown when dry; not extending to the edge, which is pale and tomentose. (*Berkeley.*)

A true *Stereum*, furnished with a characteristic strigose pileus.

Stereum rimosum, *Berk.* Umbonato-sessile, coriaceum; pileo zonato, subtiliter pubescente, radiato, ruguloso; hymenio pallido, hic illic lutescente rimoso; sporæ globosæ, 6–7 μ diam.—*Berk. in Hook. Kew Journ. Bot.* iii. p. 169. (Type in Herb. Berk. 3815.)

On vegetable soil, old trees, &c. Darjeeling, 7500 feet; Ceylon; Cordova.

Coriaceous, but probably when fresh of a more watery texture than others, in consequence of which it is minutely wrinkled longitudinally when dry; 1 inch or more long, 2–3 inches broad, umbonate, sessile, effused behind, wood-coloured, with brown fasciæ, and numerous narrow zones minutely tomentose, wrinkled longitudinally. Hymenium whitish, here and there assuming a yellow tinge; much cracked, with the fissures silky within. Undoubtedly allied to *S. ostrea* and *lobatum*, but differing in its cracked pale hymenium and other points. (*Berkeley.*)

In some of the type specimens reniform or suborbicular, pileus tomentose and zoned, ochraceous with brown tinge; hymenium similar in colour, much cracked; plant rather thick, rigid when dry.

Stereum contrarium, *Berk.* Rigidum, conchiforme; pileo nigro-zonato, hispido, hic illic glabrescente, margine pallido; hymenio candido, revivescente; sporæ ellipsoideæ, 7×4–$5\ \mu$.—*Berk. in Journ. Linn. Soc.* (*Bot.*) xvi. p. 52. (Type in Herb. Kew.)

Japan (‘*Challenger*’ *Exp.*); N. Zealand.

Stereum rhicnopilus, *Massee.* *S.* pileo effuso-reflexo, semi-orbiculari, membranaceo, concentrice sulcato, postice nudo, ruguloso, versus marginem levissime hirsuto albo-sordido; hymenio glabro, lutescente.—Thelephora (Stereum) rhicnopilus, *Lév. in Ann. Sci. Nat.* sér. 3, v. p. 148.

On trunks. Chili.

Resembling *S. hirsutum*, but thinner and strigose only towards the margin, the remainder being covered with little raised lines which spread from the base in a radiating manner towards the margin.

Stereum radians, *Fr.* (Pl. VII. f. 5.) Umbonato-sessile, coriaceo-rigidum, utrinque applanatum, glabratum, nitidum, a basi dense fibris innatis radians, zonis badiis variegatum; hymenio levi, pallescente; sporæ subglobosæ, $4\ \mu$ diam.—*Fr. Nov. Symb. Myc.* p. 110. (Specimen from Fries in Herb. Berk. n. 3772.)

On wood. Mexico.

Intermediate between *S. sericeum* and *S. complicatum*, very thin, but rigid, margin often lobed, lobes overlapping; pileus silky, with fine deep furrows radiating to the margin.

Stereum cinereum, *Lév.* *S.* pileo effuso-reflexo, obsolete zonato, tomentoso-spongioso, cinereo; margine undulato, obtuso, inflexo; hymenio glabro et lurido nigricante.—*Lév. in Ann. Sci. Nat.* sér. 3, i. p. 211.

On trunks. Sumatra.

Pileus coriaceous, margin obtuse, wrinkled below like an *Auricularia*, zones indistinct; tomentum giving a sponge-like appearance to the pileus, which becomes brown or black with age.

Stereum sanguinolentum, *Fr.* Coriaceum, tenue; pileo effuso reflexoque, adpresse sericeo, substriato, pallido; margine acuto, albo; hymenio levi, glabro, cinereo-fuscescente, tactu cruentato, exoleto pruinoso; sporæ cylindraceo-ellipsoideæ, leniter curvulæ, 8–9 × 4–5 μ.—*Fr. Epicr.* 549; *Hym. Eur.* 640; *Berk. Outl.* p. 271.—Thelephora sanguinolenta. *Alb. et Schw.* p. 274; *Syst. Myc.* i. p. 440; *Grev. Scot. Cr. Fl.* t. 225. Stereum rigens, *P. Karst. Symb. Myc. Fenn.* x. p. 64.—*Exs.*: Rab. F. Eur. 210; Rab.-Wint. Fung. Eur. 3030; Fuckel, Fung. Rhen. 1320 & 2395; Syd. Myc. March. 502; Roum. Fung. Gall. 2212; P. Karst. 131; Thuem. Myc. Univ. 2010 & 2111.

On pine and other wood. Britain; Europe; N. America; N. Zealand.

Agrees with *S. rugosum* in becoming red when bruised, but distinguished by the smaller, slightly curved spores and the naked hymenium.

Stereum disciforme, *Fr.* Subcoriaceum, album; pileo resupinato, determinato, ambitu tenui libero nudo marginate disciformi; hymenio inæquabili, pulverulento; sporæ subglobosæ, 16–18 vel 18 × 15–16 μ.—*Fr. Epicr.* p. 552; *Fr. Hym. Eur.* p. 642; *Pat. Tab. Analyt.* p. 250?—Peniophora disciforme, *Cooke, Grev.* viii. p. 20, t. 122. f. 2.

On oak. Britain; Europe.

After a careful examination of specimens from various countries, I fail to find cystidia, all the specimens examined agreeing in the rigid, uneven, pallid (when dry) hymenium, which is pulverulent with the copious very large spores.

Stereum simulans, *Berk. & Broome.* Pileo orbiculari, rigido, rugoso, tomentoso, margine reflexo; hymenio glabrato, pallido-

ochraceo, contextu rhabarbarino.—*Berk. & Broome in Trans. Linn. Soc.* ser. 2, *Bot.* ii. p. 64, pl. xiii. ff. 5–15.

Brisbane.

This species is intermediate between *S. rugosum* and *S. lobatum*. The pileus is tomentose, gilvous, slightly reflexed and zoned; the hymenium uneven, glabrous, of a brownish-ochre colour, and concentrically zoned, fixed by the centre; when young cup-shaped; the substance rhubarb-coloured. It is much more rigid than *S. lobatum*, differing from *S. rugosum* in the substance of the pileus. (*Berk. & Broome.*)

Stereum coffeatum, *Berk. & Curt.* Primum orbiculare dein postice decurrens, antice reflexum, zonatum, umbrinum, rugulosum; hymenio pallide rimoso; sporæ ellipsoideæ, 6–7 × 5 μ.—*Berk. & Curt. in Grev.* i. p. 164. (Type in Herb. Berk. n. 3806.)

On oak. S. Carolina.

"A fine species, somewhat resembling *S. bicolor*. At first orbicular, then decurrent behind, broadly reflexed above, coffee-coloured, zoned, marked with minute radiating wrinkles, very minutely pubescent, repeatedly zoned; hymenium ochraceous." (*Berkeley.*)

Rather soft and crumbling when dry; hymenium more or less cracked in every specimen.

Stereum spadiceum, *Fr.* Coriaceum; pileis effuso-reflexis, villosis, subferrugineis; margine obtusiusculo, albo; hymenio glabro, fuscescente, vegeto trito sanguinolento; sporæ ellipsoideæ, 8 × 5 μ.—*Fr. Epicr.* p. 549; *Hym. Eur.* p. 640; *Berk. Outl.* p. 270.—Thelephora spadicea, *Fr. Elench.* p. 176. Cellularia cyathiformis, *Sow.*, *herb.* (small pezizæform specimens).—*Exs.*: Thuem. Austr. 921; Oudem. Fung. Neerl. 233; Cooke, Fung. Brit. 144; Berk. Brit. Fung. 144; Ellis, N. Amer. Fung. 325; Rav. Fung. Car. 32; Cooke, Brit. Fung. ed. 2, p. 107.

On trunks. Britain; Europe; United States; Canada; Vancouver Island; Japan; Sikkim Himalayas; Juan Fernandez; Tasmania; S. Australia; Malay Peninsula.

Stereum Sarmienti, *Speg.* *S.* pileis solitariis vel laxe gregariis, subscutato-resupinatis, 1–2 cm. diam., ex orbiculari difformibus, subliberis, reflexis, lignosis, duris, crassiusculis, extus glabris sordide testaceo v. testaceo-canescentibus; margine parce repan-

dulo (subcrispato in sicco) non vel vix pruinuloso; hymenio plano vel undulato, in juventute pallide rufescente, carne pruinuloso, per ætatem stratose revivescente, stratis inferis sordide testaceis.—*Speg. Fung. Fueg.* n. 85.

On old trunks of *Fagus antarctica*. Tierra del Fuego.

A very fine species, at first sight recalling an old form of *Stereum rugosum*.

STEREUM SERICEO-NITENS, *Speg.* *S.* pileis sparsis vel laxe aggregatis, sæpe confluentibus, coriaceis, rigidulis, effuso-reflexis vel subcupulato-resupinatis, 2–3 cm. diam.; margine acutis, superne dense laciniato-lobatis, extus adpresse puberulis vel subvillosis, postice rufescente-subtabacinis, antice canescentibus, sericeo-nitentibus, non vel vix obsoleto-zonatis; hymenio plano vel spurie undulato vel tuberculoso lutescenti-carneo, primo parce albo pruinuloso.—*Speg. Fung. Fueg.* n. 86.

On fallen decayed beech-trunks. Tierra del Fuego.

STEREUM RUGOSUM, *Fr.* Suberosum, rigidum; pileo effuso breviterque reflexo, obtuse marginato, demum glabro, spadiceo; hymenio impolito, pruinoso, trito subcruentato; sporæ cylindraceo-ellipsoideæ, utrinque obtusissime, $10–12 \times 4–5\ \mu$. A, hymenio lutescente; B, cinereo-livido.—*Fr. Epicr.* p. 552; *Hym. Eur.* p. 643; *Berk. Outl.* p. 271.—Thelephora Laurocerasi, *Berk. in Sm. Eng. Fl.* v. pt. 2, p. 173 (specimen from Fries in Herb. Berk. n. 3801).—*Exs.*: Jack, Leiner u. Sitz. 837; Thuem. F. Aust. 331; Sacc. Myc. Ven. 409; Karst. F. Fenn. 249; Klotz. (Rab.) 503; Syd. Myc. March. 814; Roum. Fung. Sel. Gall. 504; Thuem. Myc. Univ. 1007; Cooke, Brit. Fung. ed. 2, 407; Desm. Cr. Fr. ser. 1, 523; Berk. Brit. Fung. 145.

On trunks. Britain; Europe; United States; Tierra del Fuego; S. Africa; Ceylon; W. Australia.

Very variable in form, wholly adnate, partly reflexed, or pezizæform. Agrees with *S. sanguinolentum* in becoming red when bruised, but distinguished by the pruinose hymenium and the larger straight spores.

Var. AURANTIACUM; pileo tomentoso, pallido; hymenio aurantiaco.—*P. Karst. Symb. Myc. Fenn.* x. p. 64.

On birch-trunks. Finland.

STEREUM SPEGAZZIANUM, *Massee.* Effusum, cartilagineo-coriaceum, tenue, flexibilissimum, matrici parte centrali adfixum, in vivo explanatum, in sicco ambitu late reflexo-evolutum; pileo superne albo, centrum versus sordide fuscescente, minute et molliter velutino; hymenio glabro, levissimo, pallide fulvo-melleo, azono.—Stereum pergamenum, *Speg. Fung. Arg.* Pug. iii. n. 23. Spegazzini's name is antedated by Berkeley & Curtis.

On rotten wood. Argentine Republic.

Pileus 2–3 centim. diam., 0·5–0·7 millim. thick. Related to *Stereum ochraceo-flavum* (Schw.), Fr.; differing in the slightly larger pileus, milk-white outside and not greyish white, and soft velvety, not hispid tomentose. (*Spegazzini.*)

STEREUM SUBPILEATUM, *Berk. & Curt.* Late effusum, resupinatum, crassum, suberosum a matrice solubile; hymenio ligneo-pallido, supra sulcato-zonato fulvo velutino; sporæ 6–7 × 4–5 μ. —*Berk. & Curt. in Hook. Kew. Journ.* i. p. 238; *Grev.* i. p. 163. —*Exs.*: Rav. Fung. Amer. 219; Rav. Fung. Car. 30; Ellis, N. Amer. Fung. 1025. (Type in Herb. Berk. n. 3804.)

On wood. United States.

Broadly effused, often attached by a central point and numerous individuals becoming confluent, firm, strigose, dingy brown or orange-brown; margin often paler; zones showing through as elevations on the pallid cracked pileus.

Closely allied to *Stereum rugosum.*

STEREUM SULPHURATUM, *Berk. & Rav.* Pileo reflexo, lobato, crispato, sulphurato, hispido, subspongioso; hymenio pallido, undulato; sporæ ellipsoideæ, 5 × 3 μ.—*Berk. & Rav. in Journ. Linn. Soc.* (*Bot.*) x. p. 331. (Type in Herb. Berk. n. 3779.)

On dead wood and branches. Cuba; United States; Venezuela; Melbourne.

Usually attached by the centre, margin free and upturned, densely strigose, sulphur-colour or pallid; hymenium pallid or pale vinous, with ochraceous tint. Whole plant often whitish, with the least possible tinge of sulphur. Many specimens often become confluent.

STEREUM TRISTE, *Berk. & Curt.* Orbiculare, margine tantum libero; pileo sursum ezonato, tomentoso, fusco; hymenio rugoso, pruinoso, umbrino vel cinereo-livido, contextu fusco; sporæ ellipsoideæ, 5 × 3–4 μ.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 332.—*Exs.*: Fungi Cubenses Wrightiani, 406. (Type in Herb. Berk. Kew. n. 3814.)

On stumps and branches. Cuba; United States.

About 1 inch across, attached by the centre, circular or irregular, owing to confluence of several individuals, almost smooth below; hymenium sometimes cracked.

STEREUM VARIOLOSUM, *Speg.* *S.* pileis scutato-resupinatis vel effusis, late arcteque matrici adnatis, solitariis vel gregariis et confluentibus, ambitu stricte marginato-reflexis, 2–3 cm. diam., extus parce atque grosse fibroso-villosis, ligneo-pallescentibus vel pallide rufescentibus; hymenio levi, plano vel spurie undulato et tuberculato, azono, pallide lutescente vel carneo-lutescente, non vel vix pruinuloso, punctis minutissimis (sæpe vix lente tantum conspicuis) rufescentibus laxe adsperso donatis.—*Speg. Fung. Fueg.* n. 88.

On fallen putrescent trunks. Tierra del Fuego.

STEREUM VITILE, *Fr.* Effuso-reflexum, coriaceo-membranaceum, molli-flaccidum; pileo contracto, leproso, floccoso, impolito sulcis concentricis notato, canescenti-fusco, opaco; hymenio glabro, inæquabili, lurido-fuscescente.—*Fr. Fungi Natal.* p. 23.

On trunks. Natal.

Very thin; related to *S. spectabile* and *S. umbrinum*.

STEREUM VERSIFORME, *Berk. & Curt.* Fuscum, crassiusculum, primum orbiculare; margine tenui, elevato, tomentoso; hymenio brunneo hic illic papillato; sporæ ellipticæ, $7 \times 5\ \mu$.—*Berk. & Curt. in Grev.* i. p. 164.—*Exs.*: Thuem. Myc. Univ. 307. (Type in Herb. Berk. n. 3854.)

On dead branches. United States; Socotra.

Small, at first orbicular, often becoming confluent, rather thick, adnate; margin free, upraised, byssoid or strigose, blackish below; hymenium clear or dingy brown.

STEREUM AMŒNUM, *Massee.* Gregarium; pileo coriaceo, membranaceo, resupinato, oblongo-ovato, zonato, hirsuto, albo; ambitu libero, tenui; hymenio lævi, carneo-purpurascente, contextu floccoso concolore.—Thelephora (Stereum) amœna, *Lév. in Ann. Sci. Nat.* sér. 3, v. p. 149.

On fallen branches. Chili.

Pileus membranaceous, 2–3 decim. long, resupinate, adhering at the centre; margin free, white, zoned, tomentose; hymenium smooth, with a slight purple tinge.

STEREUM VORTICOSUM, *Fr.* *S.* pileo coriaceo, effuso-reflexo, obscure zonato, strigoso-hirsuto, pallido; margine concolore; hymenio subcostato, glabro, purpurascente; sporæ ellipsoideæ, $7 \times 4\ \mu$.—*Fr. Obs.* ii. p. 275; *Hym. Eur.* p. 639; *Bull.* t. 483, ff. 1–5.

On bark and wood. Britain; Europe.

Intermediate between *S. purpureum* and *S. hirsutum*; the hymenium resembling the former in colour, and the pileus the latter, but readily distinguished by its thinner subcartilaginous substance, which contracts and becomes more or less torn in consequence when dry.

STEREUM COFFEARUM, *Berk. & Curt.* *S.* pileo leviter reflexo, zonato, tenui, hispidulo, cinereo; hymenio rugoso, pruinoso, brunneolo; contextu umbrino; sporæ ellipsoideæ, $5 \times 3\ \mu$.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 332.—*Exs.*: Fungi Cubenses Wrightiani, 407. (Type in Herb. Berk. Kew. n. 3807.)

On coffee-trees. Cuba.

Broadly effused, thin, adnate, following the irregularities of the bark, with free lobed margin; pileus silky, coffee-colour or greyish; hymenium grey with tinge of brown.

STEREUM ALBO-BADIUM, *Fr.* Coriaceum, rigidum, effusum, determinatum, planum; ambitu sublibero, tenui, velutino, albicante; hymenio badio, cinerascente; sporæ ellipsoideæ, $6 \times 4\ \mu$.—*Fr. Epicr.* p. 251.—Thelephora albo-badia, *Schw. Syn. Car.* 1045; *Syn. N. Amer. Fung.* p. 661.—*Exs.*: Rav. Fung. Car. 29; Rav. Fung. Amer. 221 & 449; Ellis, N. Amer. Fung. 15.

On bark and wood. United States.

Often broadly and irregularly effused from the confluence of several individuals; margin whitish, free, more or less upraised, velvety below; hymenium varying from reddish brown, through bay, to bright grey.

STEREUM SERIATUM, *Berk. & Curt.* Disciforme, tandem elevatum; hymenio albo, sericeo, cinnamomeo, latere elevato spadiceo; sporæ ellipsoideæ, $5 \times 3\ \mu$.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 332.—*Exs.*: Fung. Cub. Wrightiani, 410. (Type in Herb. Berk. n. 3848.)

On bark. Cuba.

White, thickish, entirely adnate with abrupt margin, or with one side more or less free.

Stereum paraguariense, *Speg.* *S.* pileis late effusis, 5–10 cm. diam., ambitu plus minusve reflexis, late imbricatis vel lateraliter seriatim confluentibus, crassiusculis, 2–5 mm. crass., intus laxe floccoso-fibrosis, testaceis, coriaceis, flaccidis, maxime flexibilis, dorso grosse concentrice rugoso sulcatis, tactu mollissimis (basim sterilem Lycoperdi cujusdam fibroso-stipatam perfecte æmulantibus) glabris, opacis vel vix subsericeo-nitentibus, pallide testaceis; margine crasso, obtuso, concolore, repandulo; hymenio sordide et obscure purpureo-violaceo, imperspicue velutino, non vel obsoletissime concentrice undulato, grosse irregularissimeque, præcipue ad peripheriam, longitudinaliter scruposo-rugoso, rugis antice acutis ac crispatis; margine vix pallidiore.—*Speg. Fung. Guaran.* Pug. i. n. 75.

On decayed wood. Paraguay.

Stereum rigidum, *Lév.* *S.* pileo coriaceo, reflexo, hirsuto, sulcato tenuissimeque zonato, pallide ochraceo; hymenio glabro, concolore, tandem rimoso.—*Lév. in Ann. Sci. Nat.* sér. 3, i. p. 211.

On trunks. Java.

Stereum radiatum, *Peck.* Resupinatum vel leniter reflexum, suborbiculare vel effusum, atro-brunneum; hymenio inæquali, rugis e centro radiantibus notato, cinnamomeo.—*Peck,* 26*th Report New York State Mus.* (1872).

On logs. Catskill Mountains, United States.

Stereum adustum, *Lév.* Imbricatum; pileis reflexis, coriaceis, membranaceis, sessilibus, zonatis, velutinis, fuligineis; hymenio glabro, spadiceo; sporæ ellipticæ, $6 \times 4\ \mu$.—*Lév. in Ann. Sci. Nat.* sér. 3, i. p. 213.—Thelephora (Stereum) adusta, *Lév. in Voy. 'Bonite,'* pl. 139. f. 2. (Specimens from Léveillé in Herb. Berk. Kew. n. 3785.)

On trunks and branches. Island of Luzon, Manillas.

Imbricate, with the pilei grown together or resupinate, 1–1½ inch broad, thin, rigid, rugose; pileus velvety, or silky-strigose, sometimes obscurely zoned, dirty ferruginous; hymenium dingy olive-brown.

Stereum Curtisii, *Berk.* Effusum, primum orbiculare, ferrugineum; margine tenui, subbyssoideo, pallidiore, quandoque utrinque libero; hymenio rugoso, subtiliter velutino; sporæ ellipsoideæ, $5 \times 3\text{–}4\ \mu$.—*Berk. in Grev.* i. p. 164. (Type in Herb. Berk. Kew. n. 3833).—*Exs.*: Rav. Fung. Car. 26; Ellis, N. Amer. Fungi, 16; Rav. Fung. Amer. 222, 446; Thuem. Myc. Univ. 113.

On branches. United States; Vera Cruz.

"At first orbicular, ferruginous, with a paler, somewhat byssoid margin, then effused; edge sometimes free on either side; hymenium more or less rugose; when perfect of a brighter or duller ferruginous tint. This species connects *Stereum* very closely with *Hymenochæte*." (*Berkeley*.)

Often broadly effused on bark, and with the general appearance of *Hymenochæte tabacina*, thin, irregularly nodulose, from dirty cinnamon to brownish umber, adnate, margin strigose, in old plants sometimes almost smooth; hymenium minutely tomentose owing to the presence of slender thin-walled coloured hairs, which are not rigid and pointed as in *Hymenochæte*. At first circular, the patches often becoming confluent.

STEREUM CONSPURCATUM, *Massee*. Resupinatum, suborbiculare; margine libero, anguste reflexo, spadiceo-villoso; hymenio fuligineo-umbrino; sporæ subglobosæ, $6 \times 5\,\mu$.—Hymenochæte conspurcata, *Berk. & Curt. in herb.* (Type in Herb. Berk. n. 3718.)

On bark. Venezuela.

Forming suborbicular blackish umber thin patches $\frac{1}{4}$–$\frac{1}{2}$ inch across; margin more or less free, with sometimes a tendency to become reflexed on the upper side.

STEREUM BALSAMEUM, *Peck*. Orbiculare v. confluens, resupinatum, crassiusculum atque firmum, subtus subtiliter fulvo-tomentosum; margine libero, tenui, albido; hymenio brunneo, inæquali, quandoque concentrice zonato, tritis atro-rubro v. purpureo, demum atro.—*Peck*, *27th Report N. York State Mus.* p. 99.

On bark of *Balsamea*. U. States.

STEREUM CHARTACEUM, *W. Mey*. Chartaceo-membranaceum; pileis cæspitosis, rotundatis, subimbricatis, glabris, zonatis, incanis, marginem versus hymenioque lævi farinoso ochraceis.—*W. Mey. Esseq.* p. 305; *Fr. Epicr.* p. 546.

On branches. Surinam.

STEREUM INDURATUM, *Berk*. Durissimum, conchiforme, concentrice sulcatum, velutinum; hymenio lævi, subtiliter pulverulento, contextu rhabarbarino; sporæ subglobosæ, $6 \times 5\,\mu$.—*Berk. in Journ. Linn. Soc.* (*Bot.*) xvi. p. 44. (Type in Herb. Kew.)

Aru Is. (' *Challenger* ' *Exp.*).

Pileus 3 in. across. Distinguished at once by its very hard thick substance from *S. ostreatum* and its allies. (*Berkeley.*)

Thick, with the habit of a resupinate *Polyporus.*

STEREUM NOTATUM, *Berk. & Broome.* Effusum; margine tomentoso, pallido, libero; hymenio hic illic concentrice notato, pallido, glabro; sporæ ellipsoideæ, $7 \times 5\ \mu$.—*Berk. & Broome in Journ. Linn. Soc. (Bot.)* xiv. p. 66. (Type in Herb. Berk. n. 3835.)

On bark Ceylon.

Thin, broadly effused, and consisting of several confluent patches; edge thin, papery, strigose or tomentose; hymenium marked with concentric rings, and judging from the stains in the dry specimens, giving out a red juice when bruised.

STEREUM LEVEILLIANUM, *Berk. & Curt.* Effusum, resupinatum, molle, crassiusculum, carneum; margine libero, tomentoso; sporæ subglobosæ, $6 \times 5\ \mu$.—*Berk. & Curt. in Grev.* i. p. 163.—Corticium Leveillianum, *Berk. & Curt. in Hook. Kew Journ.* i. p. 238. —*Exs.*: Rav. Fung. Car. 35. (Type in Herb. Berk. n. 3831.)

On fallen branches. S. Carolina; Central America.

"At first forming little peltate orbicular spots, which as they dilate become closely attached to the matrix, with the exception of the margin which is often free, soon confluent, soft, rather thick, of the colour of raspberries and cream. Hymenium often minutely pitted. Old specimens lose in a great measure their ruddy hue, and are of a dead white." (*Berkeley, l. c.*)

Adnate, with tomentose margin usually free and upraised, patches often becoming confluent; hymenium opaque, pink or whitish.

STEREUM FERREUM, *Berk. & Curt.* Effusum, durum, rigidum, coffeatum, stratosum; margine elevato, sublobato; hymenio hic illic colliculoso, glabro; contextu umbrino; sporæ ellipsoideæ, $5 \times 3–4\ \mu$.—*Berk. & Curt. in Journ. Linn. Soc. (Bot.)* x. p. 332. —*Exs.*: Fungi Cubenses Wrightiani, 408. (Type in Herb. Berk. Kew. 3868.)

On bark and wood. Cuba.

Often broadly effused, thickish, following the irregularities of the matrix, sometimes without a free margin, umber-brown. Allied in some respects to *S. subpileatum*, Berk.

IV. *Adglutinata, effusa ; ambitu non vel vix libero.*

Stereum rubberrimum, *Berk. & Broome.* Pulvinatum, crassiusculum; hymenio pulchre rubro, in basi nigra insidente; margine angustissimo, albo; sporæ ellipsoideæ, $6 \times 4\ \mu$.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 67. (Type in Herb. Berk. Kew. n. 3853.)

On lichens and wood. Ceylon.

Small, thickish, variously lobed, vermilion or lake, with usually a very narrow pale margin.

Stereum pruinatum, *Berk. & Curt.* Effusum, rimosum; margine tenuissimo; contextu ferrugineo-fusco; hymenio subcinereo, pruinoso; sporæ ellipsoideæ, $6 \times 4\ \mu$.—*Berk. & Curt. in Journ. Linn. Soc.* (*Bot.*) x. p. 332.—*Exs.* Fung. Cub. Wrightiani, 409; Rav. Fung. Amer. 450. (Type in Herb. Berk. n. 3834.)

On wood and bark. Cuba; United States; Ceylon.

Minutely hoary, due to the presence of soft colourless hyphæ on the hymenium. Not separable from the matrix.

Stereum odoratum, *Fr.* Latissime effusum, suberosum, tenue, rigidum, indeterminatum, contiguum, arcte adnatum, ex albo alutaceo-pallidum, hymenio e velutino glabratum; sporæ ellipsoideæ, $5\text{–}6 \times 3\text{–}4\ \mu$.—*Fr. Epicr.* p. 553; *Hym. Eur.* p. 644. —Thelephora odorata, *Fr. Syst. Myc.* i. p. 445; *Elench.* p. 207; *Weinm. Ross.* p. 395. (Specimen from Fries in Herb. Berk. Kew.)

On pine-wood. Europe; N. America.

Thick, rigid, following the inequalities of the matrix, firmly adnate; hymenium cracked, pale ochre, substance dark ochre. Smell strong.

Stereum rufum, *Fr.* Coriaceo-cartilagineum, erumpens, e tuberculiformi subrotundum, marginatum, rufum, fuscescens, subtus glabrum; hymenio griseo-pruinoso, demum bullato-tuberculoso, interdum rimoso; sporæ ellipsoideæ, $6\text{–}7 \times 4\ \mu$.—*Fr. Epicr.* p. 552; *Hym. Eur.* p. 644.—*Exs.*: Rab. Fung. Eur. 1407.

On bark of lime. Scotland; Europe.

Bursting through the bark as rounded patches, which spread for some distance, keeping more or less circular in outline, *thin*, extreme margin free; looking rather like a *Corticium* in habit; hymenium with small tubercles often arranged in indistinct concentric circles.

STEREUM MICRASPIS, *Speg.* *S.* pileis peltatis, 1–2 cm. diam., applanatis, solitariis vel gregariis ac confluentibus, coriacellis, 0·5–1 mm. crass., rigidis, matrice sublaxe adnatis, ambitu non vel vix liberis, sordide obscureque ferrugineis vel umbrinis, primo pulvere tenuissimo subdetersili griseo adspersis, dein sæpe nudis centro leniter umbilicatis, concentrice undulatis, margine obtusulo concolore, rotundato, integro, regulari.—*Speg. Fung. Guaran.* Pug. i. n. 76.

On bark. Paraguay.

STEREUM GLAUCESCENS, *Fr.* Resupinatum, submarginatum, rigidum, glabrum, umbrino-nigrescens; hymenio inæquali, primo concolore, adulto glaucescente.—*Fr. Hym. Eur.* p. 644.

On wood. Norway.

Orbicular when young, then irregularly confluent, immarginate.

STEREUM FRUSTULOSUM, *Fr.* Lignosum, resupinatum, tuberculosum, stipatum et quasi confluens, inde frustuloso-diffractum apparens, subtus et ambitu obsolete marginato glabrum, spadiceo-nigricans; hymenio convexo, e cinnamomeo expallente, pruinoso; sporæ ellipsoideæ, utrinque subacutæ, 4–5 × 3–3·5 μ.—*Fr. Epicr.* p. 552; *Hym. Eur.* p. 643.—Thelephora frustulosa, *Fr. Syst. Myc.* i. p. 445. (Specimen from Fries in Herb. Berk. n. 3844.)—*Exs.*: Fuckel, Fung. Rhen. 1317; Desm. Cr. Fr. sér. 1, n. 2163; Moug. & Nest. 680; Rav. Fung. Car. 34; Thuem. Myc. Univ. 308; Roum. Fung. Gal. 703; Ellis, N. Amer. Fung. 106; Roum. Fung. Sel. Gall. 206; Syd. Myc. March. 1205.

On wood and bark. Britain; Europe; United States; Cuba; New Zealand.

Some states superficially resemble *Corticium polygonium*. Thick, tuberculose small patches almost confluent; the patches are often cracked completely through, so that the whole presents a tesselated appearance; hymenium usually cinnamon, becoming paler, but sometimes brown.

STEREUM HAYDENI, *Berk. in herb.* Resupinatum, late effusum, determinatum, crassiusculum, matrici totum adhærens; hymenio glabro, rufo-ochraceo, rimoso; sporæ ellipsoideæ, 7 × 4–5 μ.

On wood. Ohio, U.S.

Broadly effused, thick, following the irregularities of the wood, rather thick when dry, firm; hymenium ochraceous, with tinge of red here and there or reddish-ochre all over, cracked, showing the paler subiculum; margin irregular, thin.

STEREUM LÆVIGATUM, *Speg.* Resupinatum, effusum, coriaceo-cartilagineum, perfecte determinatum, crassiusculum, matrici totum adhærens, quandoque hic inde ambitu vix liberum; pileis orbicularibus sæpe pluribus confluentibus, applanatis centro plus minusve rugoso-scrupulosis, pluries concentrice fumose zonatis, carneo-fuscescentibus, nubilosis, zona carneo-flavescente latiuscula ornatis.—*Speg. Fung. Arg.* Pug. iii. n. 24.

On beams forming a bridge. Argentine Republic.

Pileus 3–10 centim. diam. Perhaps a state of some *Merulius.*

Var. MESOPODA, *Speg. Fung. Arg.* Pug. iv. n. 31; pileis orbicularibus, 10–15 mm. diam., udis carnosulo-lentis, flexibillissimis subhygrophanis, explanato-subcupulatis, vix centro umbonatulis, siccis cupulato-contractis, umbone centrali valde prominente, umbilicato, intus glaberrimis carneo-subpurpureis, lineis saturatioribus v. pallide fulvescentibus zonatis, margine integerrimo obtusiusculo, extus etiam glabris pallide et sordide fulvescentibus, centro in stipitem parvulum 2–3 mm. 1·5–2 mm. crassiusculum glabrum abrupte attenuatis.

On rotten worked wood. Argentine Republic.

STEREUM INSULARE, *Berk. & Broome.* Totum resupinatum, irregulare fusco-limitatum; hymenio sordide ochraceo, rimoso; margine strigoso, dein nudo; sporæ subglobosæ, 4 μ.—*Berk. & Broome in Journ. Linn. Soc.* (*Bot.*) xiv. p. 66. (Type in Herb. Berk. n. 3864.)

On smooth bark. Ceylon.

Thin, entirely adnate; margin blackish, byssoid or strigose when young, becoming smooth; hymenium dirty ochre, often cracked; substance blackish brown. Forming little irregular patches.

STEREUM CANDIDUM, *Fr.* Sublignosum, crassum, resupinatum, immersum, marginatum, subtus nigrum; hymenio subpulverulento, candido; sporæ ellipsoideæ, 6×4 μ.—*Fr. Epicr.* p. 552.—Thelephora candida, *Schw. Syn. Car.* n. 1069; *Syn. N. Amer. Fung.* n. 617.—*Exs.*: Rav. Fung. Car. 32; Rav. Fung. Amer. 120; Ellis, N. Amer. Fung. 1206.

N. America.

On wood. Occurring in usually small irregular patches; substance thickish, following the irregularities of the matrix, generally closely adnate; hymenium white, sometimes becoming pallid with age.

STEREUM ARENICOLUM, *Berk.* Resupinatum, effusum, crassum, rigidum, subtus tomento ferrugineo molli vesitum; hymenio levi, glabro fusco-purpurascente; sporæ ellipsoideæ, 7 × 4–5 μ. (Berk. in Herb. n. 3822.)

On sand under trees. Vera Cruz.

Rigid, thick, 2–3 inches across, attached to the sand and probably decayed wood by a dense ferruginous tomentum; margin sometimes slightly upraised; substance pale cinnamon.

STEREUM ALLICIENS, *Berk. & Cooke.* Resupinatum, arcte adnatum, læte ochraceum, glaberrimum, læve; margine angustissimo, pallidiore, tomentoso; sporæ cylindraceo-ellipsoideæ, 12 × 5–6 μ.—*Berk. & Cooke in Journ. Linn. Soc.* (*Bot.*) xv. p. 389. (Type in Herb. Berk. Kew. n. 3856.)

On sticks. Brazil, Rio Javary.

Forming patches some inches long, originally orbicular, bright ochre, very smooth, even; margin very narrow, paler, tomentose. (*Berk. & Cooke.*)

Margin sometimes free and byssoid.

STEREUM ARATÆ, *Speg.* Resupinatum, crassum, suberoso-coriaceum, orbiculari-capulare, vel plura confluentia difformia, 1–2 cm. diam., 1–2 mm. crass., subtus tomento candido molli vestitum, azonum; carne candida, coriaceo-fibrosa, tenaci; hymenio irregulariter gibboso vel plano, minutissime pruinosulo-velutino, griseo-carneo-fusco, zona fulvo-lutescente vel vivide aurantiaca marginato; sporis minutis, ellipticis vel ovoideis, quandoque inæquilateralibus, simplicibus, 3–5 × 1·5–2·5, hyalinis. —*Speg. Fung. Argent.* Pug. ii. p. 8.

On old worked wood. Argentine Republic.

Related to *S. hirsutum*, from which it differs in the softly tomentose pileus and pruinose hymenium. (*Spegazzini.*)

STEREUM ALBO-CINCTUM, *Berk. & Broome.* Effusum, resupinatum, crassiusculum; hymenio pallide umbrino vel ochraceo, subtiliter pruinoso, margine subelevato; sporæ 4 × 3 μ.—*Berk. &*

Broome in Journ. Linn. Soc. (Bot.) xiv. p. 66.—Stereum endoleucum, *Berk. & Broome in Journ. Linn. Soc. (Bot.)* xiv. p. 66. Stereum auriusculum, *Berk. & Broome, l. c.* xiv. p. 66. Stereum annosum, *Berk. & Broome, l. c.* xiv. p. 67. (Type in Herb. Berk. n. 3838; the types of the specimens given above as synonyms are also in Berkeley's Herbarium.)

On wood and bark. Ceylon; Nilghiris.

A variable species, but with transition forms connecting all the extremes; the hymenium varies from ochre through cinnamon to pale umber; the margin is sometimes indistinct, at others distinct, elevated, and whitish. Often broadly effused. The hymenium is covered with a whitish bloom due to the presence of minute amorphous particles of lime.

STEREUM ACERINUM, *Fr.* Crustaceo-adnatum, læve, glabrum, album; sporæ ellipsoideæ, 6 × 3–4 μ.—*Fr. Hym. Eur.* p. 645.—Thelephora acerina, *Pers. Syn.* p. 81; *Fr. Syst. Myc.* i. p. 453. Stereum candidum, *Schwein.* (from specimen sent by Schweinitz to Berkeley). (Fertile specimen from Fries, in Herb. Berk.) —*Exs.*: Berk. Brit. Fung. 65; Roumeg. Fung. Gall. 802; Roum. Fung. Sel. Gall. 403; Rav. Fung. Car. 37; Ellis, N. Amer. Fung. 326; Fung. Cubens. Wrightiani, 412; Moug. & Nest. 991; Sacc. Myc. Ven. 410; Thuem. Fung. Univ. 327.

On living bark of *Acer campestris*, also on fallen trunks of other trees. Britain; Europe; United States; Cuba; Australia (Swan River); Tasmania; New Zealand.

Forming a thin white crust, generally sterile. Surface usually covered with minute particles of lime.

STEREUM MEDICUM, *Curr.* Effusum, resupinatum, tenuissimum, margine subhirsuto; hymenio inæquali in prominentiis rotundis elevato, fusco-tabacino, subvelutino; sporæ ellipsoideæ, 7 × 3–4 μ.—*Curr. in Trans. Linn. Soc.* ser. 2, *(Bot.)* i. p. 127, pl. xx. ff. 9–10.

Sikkim, 5000–6000 ft. (Type in Herb. Kew.)

This is a very curious production; the pileus is very thin, but the plants grow together in a stratified mass, having exactly the appearance of being composed of thin layers of tobacco. It is used by the Lepchas in medicine, and has a native name. (*Currey.*)

Not a good *Stereum*; the hymenium at best is velvety or

fibrous, and when sterile is loose in texture, yet it does not approach *Hymenochæte*. Colour of entire plant bright rusty orange.

Stereum stratosum, *Berk. & Broome.* Effusum, læte ochraceo-album, glabrum, lutescens hic illic rugosum, contextu pallido stratoso, stratis demum solutis.—*Berk. & Broome in Ann. Nat. Hist.* ser. 5, xii. 1883, p. 574.

Penzance, Britain.

No specimen of the above species exists in the herbarium of the Rev. M. J. Berkeley, hence I am unable to supplement the above scanty diagnosis.

Stereum strumosum, *Fr.* Resupinatum, adnatum, ochraceum vel citrinum, primo tuberculiforme immarginatum, dein dilatatum, confluens, indeterminatum; hymenio levi, pulverulento; sporæ cylindraceo-ellipsoideæ, vix curvulæ, 6–4 × 3 μ.—*Fr. Nov. Symb. Myc.* p. 111. (Specimen from Fries in Herb. Berk.) —Stereum sulfureum, *Fries, MS.* (specimen from Fries in Herb. Berk.). Stereum citrinum, *Berk. & Curt. in herb.*

On wood. Mexico; United States; Cuba; Australia; Ceylon.

Commencing as rather thick, firm, isolated patches with an abrupt margin and ochraceous to bright citrin hymenium, usually soon becoming confluent and irregular in outline.

Stereum Schulzeri, *Quel.* Resupinatum; tuberculis tomentosis, erumpentibus, mox in membranas tenues irregulares a ramo solubiles explanatis, marginibus duorum individuorum concurrentibus concrescentibus, sic latas expansiones formantibus; margine fibroso albido, quod restat, sordide purpureo-fusco, molli coriaceo, subpruinato, nec piloso; plicis et papillis spuriis; hymenio genuino; pileo subtus dilute fusco, hirsuto; sporis cylindraceo-ellipticis, fuscis, 6 μ longis.—*Quel. in Hedwigia*, 1885, p. 148.

On dead branches of *Prunus Armeniaca.*

Stereum sparsum, *Berk.* Candidum vel pallide ochraceum, in pustulas duras quandoque confluentes dispositum.—*Berk. in Journ. Linn. Soc.* (*Bot.*) xiii. p. 168. (Type in Herb. Berk. n. 3805.)

On bark. Australia; Ceylon.

"Consisting of detached, roundish, hard bodies, which some-

times become confluent and form lines after the fashion of *Corticium seriatum.*" (*Berkeley, l. c.*)

Evidently an immature condition of some species. No spores were found.

Stereum siparium, *Massee.* Resupinatum; subiculo racodioideo umbrino, filamentis intertextis; hymenio inæquabili, subconcolore; sporæ ellipsoideæ, 5×2–3 μ.—Hymenochæte siparia, *Berk. & Curt. Journ. Linn. Soc.* (*Bot.*) x. p. 334. (Type in Herb. Berk. 3711.)—*Exs.*: Fung. Cub. Wrightiani, 424.

On dead wood. Cuba.

From 1–2 inches across; thin, flexible, densely shaggy, umber; hymenium spongy. Superficially resembling *Thelephora spongia.*

Stereum tumulosum, *P. Karst.* Lignosum, resupinatum, tuberculosum, stipatum et quasi confluens, inde frustuloso-diffractum apparens, obsolete marginatum, glabrum, spadiceo-nigrum; hymenio planiusculo, cinereo-pruinoso; sporis hyalinis, minutissimis.—Xylobolus tumulosus, *P. Karst. Symb.* viii. p. 11.

On bark. Lapland.

Most frequently springing from spermogonia on *Salix viminalis.* Small, about 1 millim. broad when not confluent. Allied to *Stereum frustulosum* (Karsten).

Stereum corrugatum, *Massee.* *S.* pileo coriaceo, membranaceo undique adnato, ambitu nudo mycelioque fusco-nigricantibus; hymenio rugoso-radiato, fulvo-ferrugineo.—Thelephora (Stereum) corrugata, *Lév. in Ann Sci Nat.* sér. 3, v. p. 150.

On fallen trunks. New York.

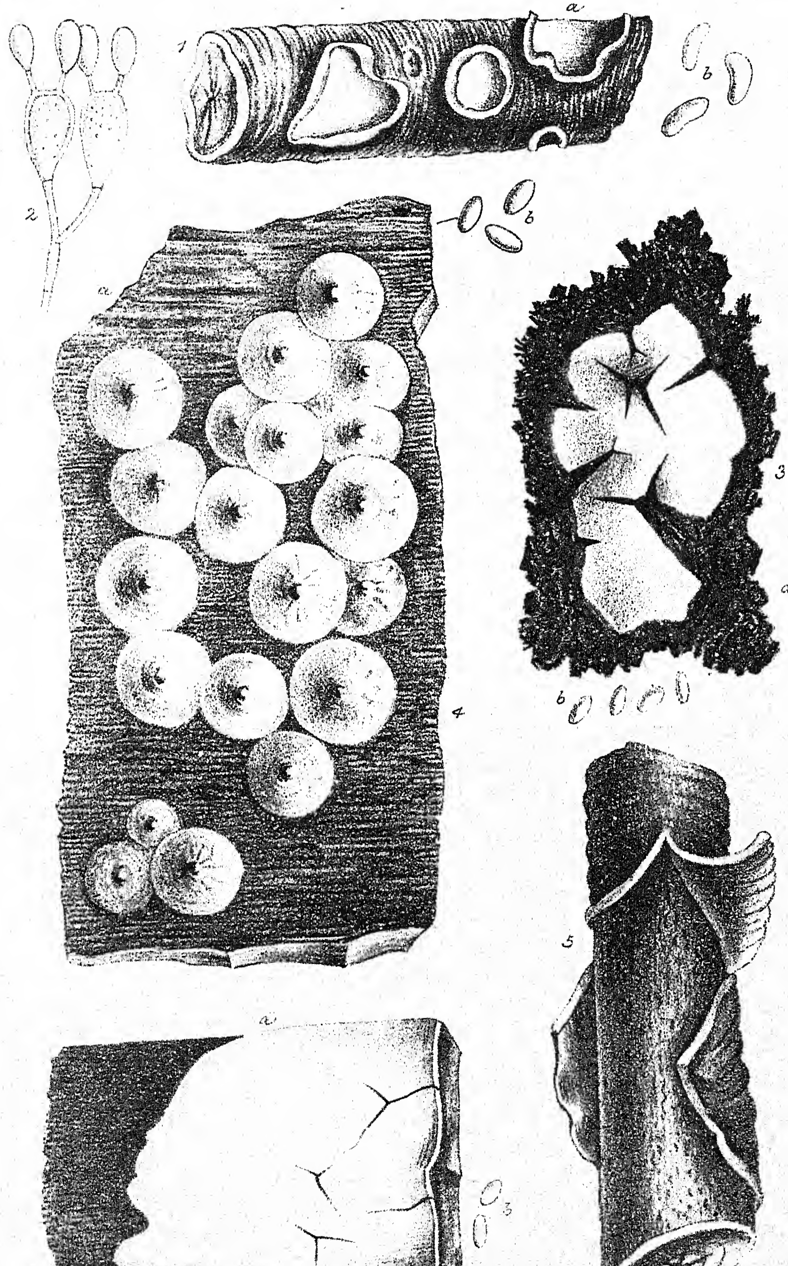
Hymenium furnished with interrupted rugose markings radiating from the centre, ferruginous, naked; margin sometimes a little raised.

Stereum tuberculosum, *Fr.* Suberosum, late effusum, indeterminatum, arcte adnatum, glabrum, nudum, pallescens, tuberculis difformibus, papillatis ubique obtectum.—*Fr. Hym. Eur.* p. 644.

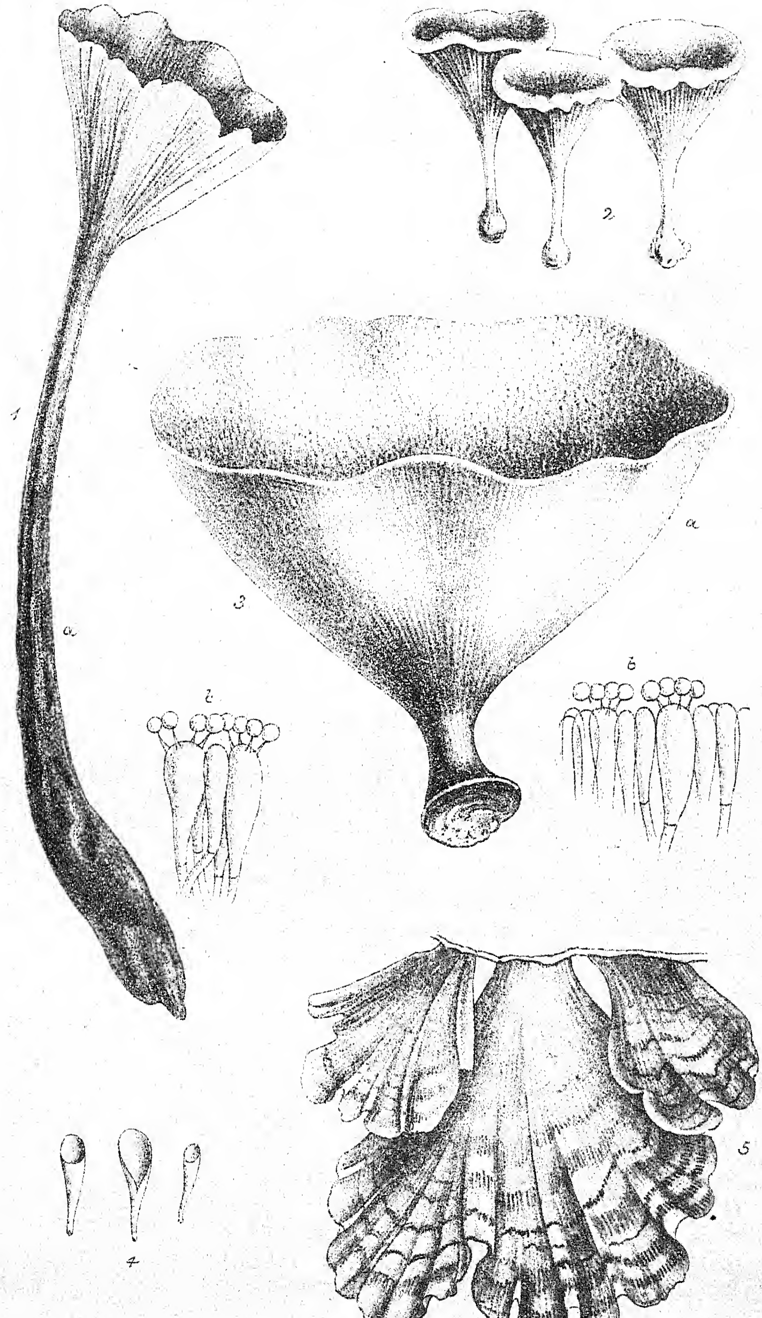
On bark. Norway.

A singular species, difficult to describe. The tubercles are covered with numerous equal papillæ.

G. Massee.



G. Massee del. J. N. Fitch lith. & imp.



G. Massee del. J.N. Fitch lith & imp.

DESCRIPTION OF THE PLATES.

Plate V.

Fig. 1. *Hymenochæte reniformis*, Lév., nat. size.
2. *Hymenochæte tasmanica*, Massee, portion of hymenium, ×400.
3. *Hymenochæte pellicula*, Berk. & Broome, portion of hymenium, ×400.
4. *Hymenochæte pulcherrima*, Massee, portion of hymenium and spores, ×400.
5. *Hymenochæte nigrescens*, Cooke, portion of hymenium, ×400.
6. *Hymenochæte Mougeotii*, Massee, portion of hymenium, ×400.
7. *Hymenochæte scabriseta*, Cooke, portion of hymenium, ×400.
8. *Hymenochæte fimbriata*, Ellis & Everh., spores, ×400.
9. *Hymenochæte croceo-ferruginea*, Massee. *a*, plant, nat. size; *b*, cystidium, ×400; *c*, spores, ×400.

Plate VI.

Fig. 1. *Corticium salicinum*, Fr. *a*, plants, nat. size; *b*, spores, ×400.
2. *Corticium roseolum*, Massee, portion of hymenium, ×400.
3. *Corticium fœtidum*, Berk. & Broome. *a*, plant, nat. size; *b*, spores, ×400.
4. *Corticium evolvens*, Fr. *a*, plants, nat. size; *b*, spores, ×400.
5. *Corticium comedens*, Fr., plant, nat. size.
6. *Corticium calceum*, Fr. *a*, portion of plant, nat. size; *b*, spores, ×400.

Plate VII.

Fig. 1. *Stereum elevatum*, Berk. & Cooke. *a*, plant, nat. size; *b*, portion of hymenium, ×400.
2. *Stereum Ravenelii*, Berk. & Curt., plants, nat. size.
3. *Stereum cyathiforme*, Fr. *a*, plant, nat. size; *b*, portion of hymenium, ×400.
4. *Stereum Tuba*, Berk. & Broome, plants, ×3.
5. *Stereum radians*, Fr., plants, nat. size.

On the Sexual Forms of *Catasetum*, with special reference to the Researches of Darwin and others. By R. ALLEN ROLFE, A.L.S., Assistant in the Herbarium of the Royal Gardens, Kew.

[Read 21st March, 1889.]

(PLATE VIII.)

IN the sixth volume of the Journal of this Society, in 1862 (pp. 151–157), appeared a noteworthy paper by Darwin, bearing the title "On the Three Remarkable Sexual Forms of *Catasetum tridentatum*, an Orchid, in the possession of the Linnean Society." * The purport of this paper was to show that the species in question had been observed to produce three distinct kinds of flowers, belonging to the same number of supposed genera, all on the same plant. Each of the three forms was represented by a woodcut. The explanation given of this curious phenomenon was that the three forms represented, respectively, the male, female, and hermaphrodite states of the same species.

This paper was a remarkable one in many respects. In the first place, it established conclusively the fact—already more than suspected by Schomburgk—that the so-called sportive character of *Catasetum*, or the curious habit of its species of suddenly producing flowers of a totally different kind (usually termed "monsters") on the same plant, was simply an abnormal combination of different sexual forms in the same individual. In the second place, it described, fully and graphically, the remarkable structural adaptations by which self-fertilization was prevented and cross-fertilization (by insect agency) secured. And, in the third place, it indicated a condition of things which, I venture to think, is unparallelled in the entire Vegetable Kingdom, namely —the production, by one and the same species, of one kind of flowers, wholly male, of a second kind, wholly female, dependent on a highly complex process for their fertilization; and of yet a third kind, hermaphrodite in character, yet *not cleistogamous*—in other words, still highly specialized and incapable of self-fertilization.

* The accounts given by the same author in his work 'On the Various Contrivances by which British and Foreign Orchids are Fertilized by Insects,' ed. 1, pp. 236–247, and in Ann. Sc. Nat. sér. 4, xix. pp. 247–255, t. 12. fig. A, are substantially identical.

This third point, however, was not established on the same firm foundation as the two former ones; and to this alone may be attributed the appearance of the present paper. The whole subject is one of peculiar fascination and clothed with a halo of romance; but, as soon as I thought seriously on the matter, the altogether anomalous character of the so-called hermaphrodite flowers was apparent; and I was so impressed with the improbability of Darwin's explanation being the correct one, that I determined, as soon as the opportunity presented itself, of going over the whole ground again. The results have been of a somewhat, though perhaps not altogether, unlooked for nature. Briefly, they may be stated, at the outset, as follows:—

1. Only two kinds of flowers, male and female, are produced by the species of *Catasetum* investigated by Darwin; and with the exception of the section *Pseudocatasetum* (*vide infrà*, p. 224), and a doubtful example noted on pp. 214, 215 (*C. Gnomus*), this appears to be the normal habit of the species generally.

2. The so-called hermaphrodite form is simply a male—the corresponding sex of the female investigated by Darwin; and the two do not belong to *Catasetum tridentatum* at all, but to *C. barbatum*, Lindl.

3. Darwin's male form is the only one which belongs to *Catasetum tridentatum*,—that is, limiting the use of the term to the forms actually examined by him (and figured); for the female of this very plant had been previously figured *, and the figure was doubtless known to the author, though supposed to be identical with the one he himself had examined.

From this it will appear that the author has fallen into some error, the nature and origin of which must now be traced.

The statement that three distinct kinds of flowers had been observed all growing on the same plant † is really based on the observations of Schomburgk; but these were unfortunately misunderstood by Darwin. What Schomburgk really stated was, that three kinds of flowers were produced by (apparently) one

* Lindley, Bot. Reg. t. 1752.

† "Botanists were astonished when Sir R. Schomburgk [Trans. Linn. Soc. xvii. p. 551] stated that he had seen three distinct forms, believed to constitute three distinct genera, namely, *Catasetum tridentatum*, *Monachanthus viridis*, and *Myanthus barbatus*, all growing on the same plant."—*Darwin*, Journ. Linn. Soc. vi. p. 151.

and the same species*, not by the same plant (individual). The difference may at first sight seem an unimportant one; but a moment's consideration will show that this is not the case. Had the three kinds of flowers been observed on the same individual †, no amount of reasoning could have explained away the fact. As it is, however, the possibility of two distinct species having been accidentally confused together presents itself; and this is what has really taken place. It may appear singular that two such very different looking plants as *Catasetum tridentatum* and *C. barbatum*—that is the male forms, to which the names were exclusively applied,—should ever have been confounded together; but on looking at the females only of the two species, there appears nothing very remarkable in the fact that they should have been thought identical ‡. Here we have the key of the situation. The female forms of the two—and indeed of several others—are remarkably alike; consequently the fact that they belonged to quite distinct species was entirely overlooked, not only by Darwin, but by other writers.

* "In a letter which I had the pleasure to address to Mr. Bentham, on the 28th of June last year, I informed him of a remarkable Orchidaceous plant, from appearance a *Monachanthus*, which on one side of the bulb produced a scape with six flowers of *Monachanthus viridis* and two of *Myanthus barbatus*, while a second scape on the same bulb had twenty-five blossoms of the *Myanthus barbatus*. . . . . The thought impresses itself, therefore, forcibly upon me, that the genera *Monachanthus*, *Myanthus*, and *Catasetum* form but one genus; and in this conclusion I am borne out by the following observations.

"A vigorous plant, which produced at its former state of inflorescence the flowers of *Monachanthus viridis*, had two months ago a scape with flowers of *Catasetum tridentatum*. . . . . Mr. Bach, an enthusiastic collector of Orchidaceous plants, sowed the seed of *Monachanthus viridis* on a decayed trunk of an *Erythrina*. Among these plants, one produced a scape with the flowers of *Catasetum tridentatum*. . . . . The evidence of the present plant, which has caused these remarks, would likewise include the genus *Myanthus* in the group." —*Schomburgk*, in Trans. Linn. Soc. xvii. p. 551.

† It is clear that when Darwin said "plant," he did not mean "species;" for after describing *Catasetum tridentatum* and *Monachanthus viridis*, he proceeds to say: "We now come to the third form, *Myanthus barbatus*, often borne on the same plant with the two preceding forms."—*Darwin*, Journ. Linn. Soc. vi. p. 156.

‡ For example, *Catasetum cristatum*, var. *monstrosum*, Hook. Icon. Plant. ii. t. 177, is a plant sent to the author, in alcohol, by Dr. Nimmo. The nine uppermost flowers are female, the three lower ones male. The author remarks that he is not sure if Bot. Reg. t. 1752 [really the female of *C. tridentatum*] is not the same as the one now figured, with all its flowers metamorphosed.

That Darwin relied very largely on the statements of Schomburgk and other authors is evident; and this leads us to examine their writings in detail.

In the 'Botanical Register' for 1836 (t. 1752) a so-called *Monachanthus viridis* had been figured by Lindley, from a garden specimen; and with this Schomburgk rightly identified a form he had actually seen produced by a plant of *Catasetum tridentatum* *. But he also wrongly identified with the same a similar form, produced by a plant of *Myanthus barbatus* *. Thus, both being thought to be *Monachanthus viridis*, and having been produced by plants hitherto considered distinct, all the forms were thought to belong to one and the same species.

We must now turn to the origin of *Monachanthus viridis*. In the 'Botanical Register' for 1832, in a note under t. 1538, Lindley speaks of two new genera in the collection of Sir William Hooker; which he then describes. One of these is *Monachanthus*, which is said to differ from *Catasetum* in having the column altogether without cirrhi. The single species, *Monachanthus viridis*, he describes as growing on trees in the Corcovado, near Rio de Janeiro. This very specimen is preserved at Kew. It consists of a water-colour drawing of the entire plant, together with a single dried flower. Who sent it, I have failed to discover; but it is labelled, "From the Corcovado, near Rio de Janeiro; grows on trees. The bulbs and leaves are similar to those of a different flower." It is labelled by Lindley himself, "*Monachanthus viridis*, Bot. Reg. 1538."

The statement that the bulb and leaves are similar to those of a different flower, leads us to examine the other genus described by Lindley; for to it the note applies. The genus in question is *Myanthus*, which is said to be closely allied to *Catasetum*, but with the cirrhi situated at the base of the column. The single species, *Myanthus cernuus*, is said to have been found on trees in the neighbourhood of Rio de Janeiro. Lindley then adds:—"Perhaps *Catasetum cristatum* would be better referred to this genus." This specimen is also preserved at Kew. It consists of a complete water-colour drawing, with a dried raceme in addition; four flowers out of about fourteen alone remaining. It is labelled, "From the neighbourhood of Rio de Janeiro; grows on trees." Lindley's ticket says, "*Myanthus cernuus*, B. Reg. 1538." The

* See footnote on preceding page.

two drawings were evidently made by the same hand and at the same time, for the colours used as well as the workmanship are so identical as to leave no doubt on the subject. Looking at the two, there cannot be the slightest doubt that they represent respectively the male and female sexes of the same species.

We now return to Lindley's published figure of so-called *Monachanthus viridis* *, which appeared four years after the original description was published; but only to find that a second species is represented under the same name. Although Lindley here states this to be the original species on which the genus was founded, it is clear that such was not the case. It is simply a case of mistaken identity. At this time the connection between the plant figured and *Catasetum tridentatum*, though pointed out to Lindley, was not admitted by him, as he afterwards states †.

This appears to me to have introduced the first element of confusion into the question. The original *Monachanthus viridis*, Lindl., is evidently the female of *Myanthus cernuus*, Lindl., as above pointed out; but now Lindley complicates matters by figuring the female of a second species, namely *Catasetum tridentatum*, as *Monachanthus viridis*. The question becomes still further involved when Schomburgk figures the female of yet a third species, namely *Myanthus barbatus*, also as *Monachanthus viridis*.

Nor is this all; for in 1844 Lindley observed of *Catasetum cristatum*, "Has been found to sport into *C. tridentatum*" ‡. In fact, the idea appears to have been fast gaining ground that the ordinary conceptions about species could not be applied to *Catasetum*, which might sport into almost anything; for when

* "This is the original species on which the genus was founded. Its habit is so like *Catasetum tridentatum*, that we long doubted whether it ought to be generically separated. . . . . Our figure was made from a specimen communicated last November from Wentworth, by permission of Lord Fitzwilliam. We are not aware at what time, or by whom it was imported, but it has probably been taken for a green form of the common *Catasetum tridentatum*, and consequently no record has been kept of it."—*Lindley*, Bot. Reg. t. 1752.

† Even when Lord Fitzwilliam assured me that it was beyond all doubt an accidental sport of *Catasetum tridentatum*, I still adhered to my idea that an imported plant of *Monachanthus viridis* had been accidentally taken for the latter common plant."—*Lindley*, Bot. Reg. t. 1951 *.

‡ Lindley, Bot. Reg. xxx. Misc. p. 39.

Sir William Hooker figured *Catasetum Naso*, Lindl., he speaks of giving the name furnished by Lindley, with a feeling that it might be a sport of the original *C. tridentatum**.

It may be observed here that the idea of three supposed genera on the same plant did not actually originate with Darwin; for Lindley has a similar statement with respect to another species, namely *C. cristatum*. Speaking of an abnormal specimen of that plant, he refers to it as combining in its own proper person no fewer than three supposed genera, *Myanthus*, *Monachanthus*, and *Catasetum*†. The statement, however, is singularly unfortunate and misleading; for on referring to the accompanying plate only two kinds of flowers are represented, namely, nine females on the upper part of the raceme, and seven males underneath.

It is to this specimen that Lindley alludes when he speaks of *Catasetum cristatum* sporting into *C. tridentatum*, though this would appear to have been an after-thought; for at the time he only speaks of it as changing into a *Monachanthus*, allied to *M. viridis*.

The singular phenomenon just described by Lindley was not now observed by him for the first time. As long previously as 1826, when he figured this very species, he observes:—"The unimportance of the peculiarity which exists in the labellum is manifested in a singular manner by a curious monster of this plant, which we have observed in an individual in the Horticultural Society's Garden. Among flowers of the ordinary kind two or three others were observed in which the labellum was precisely of the same nature as that of *Catasetum tridentatum*; that is to say, destitute of the crested appendage, and perfectly galeate and naked‡." It is unfortunate that these were not represented on the plate.

This is interesting as being the first recorded evidence of the production of two kinds of flowers by the genus; and had Lindley

* Hooker, Bot. Mag. t. 4792.

† "In November 1836 His Grace the Duke of Devonshire was so kind as to put into my hands the extraordinary flower represented in the accompanying plate, which may be regarded as one of the greatest curiosities that our gardens ever produced. . . . . It is that of a plant of *Myanthus cristatus* changing into a *Monachanthus* related to *Monachanthus viridis*, and combining in its own proper person no fewer than three supposed genera, *Myanthus*, *Monachanthus*, and *Catasetum*."—*Lindley*, Bot. Reg. t. 1947 A (text numbered "1951*").

‡ Lindley, Bot. Reg. t. 966.

grasped its full significance, it is certain that he would not afterwards have described *Monachanthus* and *Myanthus* at all. As it was, however, some years afterwards he tells us he could not believe his own words, and concluded some mistake had been made *. Even when finally abandoning the two supposed genera, he had not the slightest idea of the significance of the facts observed †. Nor does he ever appear to have arrived at a solution of the difficulty, as the following will show:—"There is a circumstance observed by Mr. Schomburgk . . . which is very curious, and deserves to be recorded. In a letter . . . he says . . . 'Are you aware that *Catasetum* and *Myanthus* are not seed-bearing, but that *Monachanthus* bears seed abundantly?' I do not know what conclusion to draw from this statement; but it would be a curious fact if, as Mr. Schomburgk's observation would seem to imply, the species of *Catasetum* and *Myanthus* should prove to be sterile states of *Monachanthus*" ‡.

It is not a little remarkable that Schomburgk, coming so near, as he did, to guessing the truth, should not have seen that he had two females confused under the name *Monachanthus viridis*; but the idea of the plant having two quite different kinds of males does not appear to have aroused his suspicions. The following note will show what his ideas on the subject were:—"Here we have traces of sexual difference in Orchidaceous flowers. I have seen hundreds of *Catasetum tridentatum* on savannahs adjacent to the lake Capoeya (Arabisce coast of Essequebo), without ever finding one specimen with seeds, while those bulbs which, according to Dr. Lindley's description, belonged to *Monachanthus viridis*, astonished me by their gigantic seed-vessels" §.

* "This, I repeat, appeared to me so extraordinary a statement, especially as after seven years it had never been corroborated by any other case of the same kind, that I concluded I must have made some mistake."—*Lindley*, Bot. Reg. t. 1947 A.

† "The necessary consequence of this is that the supposed genera *Myanthus* and *Monachanthus* must be restored to *Catasetum*; and I have no doubt now, although no proof has been seen of it, that *Mormodes* must share the same fate. But which of the species have their masks on, and which show their real faces, I certainly will not at present presume to guess."—*Lindley*, Bot. Reg. t. 1947 A.

‡ Lindley, Bot. Reg. xxiv. t. 31.

§ Schomb. in Trans. Linn. Soc. xvii. p. 552.

It remained for Darwin to investigate the structure of the flowers, and to show by what remarkable mechanisms the work of fertilization was accomplished. In the case of the male and female flowers, the conclusions arrived at are thoroughly satisfactory; but the same cannot be said respecting the so-called hermaphrodite form. Of this he observes, after describing the floral envelopes:—"The antennæ are not so long as in the male *C. tridentatum*, and they project symmetrically on each side of the horn-like projection at the base of the labellum, with their tips (which are not roughened with papillæ as in the male flower) almost entering the medial cavity. The stigmatic chamber is of nearly intermediate size between that of the male and female forms; it is lined with utriculi charged with brown matter. The straight and well-furrowed ovarium is nearly twice as long as in *Monachanthus*, but is not so thick where it joins the flower; the ovules are not so numerous as in the female form, but are opaque and pulpy after having been kept in spirits, and resemble them in all respects. I believe, but dare not speak positively as in the case of the *Monachanthus*, that I saw the nucleus projecting from the testa. The pollinia are about a quarter of the size of those of the male *Catasetum*, but have a perfectly well-developed disc and pedicel. The pollen-masses were lost in the specimens examined by me; but fortunately M. Reiss has given, in the 'Linnean Transactions,' a drawing of them, showing that they are of due proportional size, and have the proper folded or cleft structure; so that there can hardly be a doubt that they are functionally perfect"*.

These results were obtained from a specimen preserved in spirit, but during last autumn Mr. F. W. Moore, Curator of the Glasnevin Botanic Garden, was good enough to send me a living raceme of the same identical form. After careful examination I can only say that the whole series of female organs are as imperfect as in any other male *Catasetum*, while, on the other hand, the male organs themselves differ in no respect whatever from those of several allied species. In other words, that the form in question is a male only, and belonging to the group in which Darwin showed that both the antennæ are sensitive; as opposed to the other group (including *C. tridentatum*), in which one only is sensitive, the other being turned round near the base of the

* Darwin, in Journ. Linn. Soc. vi. p. 156.

column and functionless. This being the case, Darwin's other remarks upon *Myanthus* * naturally fall to the ground.

Hitherto the instances of so-called "sporting" in *Catasetum* have not presented any insuperable difficulty on careful investigation, but have proved to be the occasional abnormal combination of both sexes in the same individual; whereas the species are normally diœcious,—so much so that in the majority of them the second sex is at present unknown. But now we come to another recorded instance of the production of three kinds of flowers on the same individual, of which I at present fail to discover a satisfactory explanation. Speaking of a supposed new species, *C. heteranthum*,—which, by the way, has proved identical with *C. Gnomus*, Linden & Reichb. f.,—Rodrigues remarks that he has observed three kinds of flowers borne on the same individual, corresponding to the three "subgenera" *Catasetum*, *Myanthus*, and *Monachanthus* †. Each of the three is pretty fully described, but, strange to say, there is not a word about sexual differences, neither in this case nor in that of other species of which two kinds of flowers were observed. In fact, the author does not

* "As we thus see that both the male and female organs are apparently perfect, *Myanthus barbatus* may be considered as the hermaphrodite form of the same species, of which the *Catasetum* is the male and *Monachanthus* the female.

"It is not a little singular that the hermaphrodite *Myanthus* should resemble in its whole structure much more closely the male forms of two distinct species (namely, *C. saccatum* and, more especially, *C. callosum*) than either its own male or female forms."—*Darwin*, in Journ. Linn. Soc. vi. p. 156.

"In *Catasetum* we have three sexual forms, generally borne on separate plants, but sometimes mingled together; and these three forms are wonderfully different from each other—much more different than, for instance, a peacock is from a peahen."—*Darwin*, *l. c.* p. 157.

† "In eodem individuo profert hæc species, in eodem caule seu caulibus aliis, generis tres subdivisiones."—*Rodrigues*, Gen. et Sp. Orch. Nov. i. (1877), p. 127.

"Sur une *Ayurana* (*Salix Humboldtiana*, Mart.) dans l'*Amazonas*, j'ai rencontré un exemplaire présentant un fait d'hétéranthie très-curieux; du même pseudobulbe sortaient trois tiges florales dont chacune portait séparément des fleurs des sous-genres *Catasetum*, *Myanthus*, et *Monachanthus*. Les fleurs, outre la forme, avaient le coloris très-différent. Plus tard, j'ai rencontré dans l'*igapó* du *Yanauary*, un autre individu portant sur la même tige le *Catasète* et le *Myanthus*."—*Rodr. l. c.* p. 128.

"J'ai vu dans . . . . plusieurs endroits de l'*Amazonas*, le même individu, émettre non seulement le *Myanthus* et le *Catasetum* en racèmes différents, mais aussi le même racème offrir le *Monachanthus* avec les deux autres formes." —*Rodr. l. c.* p. 206.

appear to regard any of them as sexual forms, for he constantly speaks of them as representing "sections" or "subgenera." Nor is there a word as to those most essential points—the presence or absence of the pollinia, and of the antennæ of the column, both of which strengthen my suspicions on the point just mentioned. Judging, however, by the description, the "§ *Monachanthus*" represents simply the female form, and thus presents no special difficulty. The "§ *Myanthus*" likewise appears to represent the male form, and for the following reasons:—In the first place it agrees with the plant cultivated in European gardens, and of which the Messrs. Veitch, of Chelsea, were so good as to send me a complete raceme and leaf only a very few days ago. That it is this plant Rodrigues himself asserts, in a later note (*l. c.* p. 206), for he points out that it is the one figured by Reichenbach (Xen. Orch. ii. p. 171, t. 170. fig. 5), also by André (Ill. Hort. xxiv. n. s., t. 170), though he lays claim to his own later name superseding the original one, on the ground that he first described the other forms of the species, and that it it known under the name in Brazil. Here, then, we have the *Myanthus* form, and consequently can examine its characters. First, it is not a *Myanthus* at all, confining the term to the group to which it was originally applied, and which may be adopted (in a somewhat altered sense) for a large and very natural section of the genus. It belongs to another group, hereafter defined as *Eucatasetum*, in which the lip of both sexes is superior. The ovary is atrophied, as in other males of the genus, the column comparatively elongated, the pollinia perfect, one of the antennæ standing forward and highly sensitive, and the other turned round near the base of the column and functionless, as in others of the section. Having disposed of the male and female forms of the species, there remains the so-called "§ *Catasetum*" form, which to me is a complete mystery. The complete description is here appended *, and it will be observed that it is just the essential

* "§ *Catasetum*, scapo erecto, crasso, 3–5-floribus; perianthio explanato; sepalis oblongis, acutis, concavis, patentissimis; petalis oblongis, ad basin attenuatis, cum marginibus recurvis; labello obconico, cum marginibus crispis, dentatis, recurvis, acuto in fronte; gynostemio brevi, mucronato.

"Les sépales sont vertes, fortement fasciées de brun-pourpre, les pétales vert mouchetés aussi de brun-pourpre, le labelle jaunâtre très-finement moucheté de la même couleur, ainsi que le gynostème, qui est aussi vert. La tige est verte." —*Rodr. l. c.* p. 127.

points, which alone might enable one to form some conclusion, that are omitted. Under "§ *Myanthus*," however, we read, "labello conforme *Catasetum* cum parte obconica tenuiore; gynostemio elongato mucronatissimo," so that the most obvious differences pointed out of this "§ *Catasetum*" form are the shorter few-flowered raceme, the more spreading segments, the broader conical portion of the lip, the shorter column, and somewhat different coloration. What the biological significance of these differences may be I cannot conceive, and I can only hope that some Brazilian naturalist, into whose hands this paper may fall, will be good enough to forward to Kew such material as may enable the question to be decided. A dried specimen showing the three kinds of inflorescence described would be invaluable, or even the three kinds if borne on separate plants, though in the latter case there is, perhaps, some danger of two species being confused, as on former occasions.

I propose to conclude this paper, firstly, by enumerating all the species of *Catasetum* of which both sexes are known, giving references to descriptions and figures of each sex; and, secondly, by outlining the principal subdivisions of the genus, indicating the more prominent characters and best known species of each. Many species are yet very imperfectly known, and I should be extremely obliged to any one who will try to remedy this by forwarding to Kew specimens, especially of any instances of the production of the second sexual form of a species.

I may here point out that in the previous part of this paper the names used by the several authors in question are adopted, but in the following enumeration the earliest unappropriated name of each species is invariably given precedence. Thus *Catasetum tridentatum*, Hook., has proved to be the original species upon which the genus was founded, namely *C. macrocarpum*, Rich.; the species of *Myanthus* take the same specific name under *Catasetum*; while *Monachanthus viridis* is suppressed altogether, as the name applies to the females of three distinct species of the genus.

Enumeration of Species of Catasetum of which both Sexes are known.

1. Catasetum atratum, *Lindl.*

♂. C. atratum, *Lindl. in Bot. Reg.* xxiv. (1838), *Misc.* p. 61; *id.* t. 63; *Bot. Mag.* t. 5202.

♀. C. atratum, *Lindl.*; *Rodr. Gen. et Sp. Orch. Nov.* ii. (1881), p. 220 (§ *Monachanthus*).

2. Catasetum barbatum, *Lindl.*

♂. Myanthus barbatus, *Lindl. Bot. Reg.* xxi. (1836) t. 1778; *Bot. Mag.* t. 3514; *Paxt. Mag. Bot.* ii. p. 124, with plate; *Kn. & Westc. Fl. Cab.* i. t. 37; *Schomb. in Trans. Linn. Soc.* xvii. p. 551, t. 29 (also ♀); *Darwin in Journ. Linn. Soc.* vi. p. 153, fig. 2 B; *id. Fertiliz. Orch.* ed. 1, p. 239, fig. 28 B; *id. in Ann. Sc. Nat.* sér. 4, xix. p. 247, t. 12. fig. A 4.—Catasetum barbatum, *Lindl. Bot. Reg.* xxx. (1844), *Misc.* p. 38; *Reichb. f. in Walp. Ann. Bot.* vi. p. 570.

♀. Monachanthus viridis, *Schomb. in Trans. Linn. Soc.* xvii. (1837), p. 551 (in part), t. 29 (also ♂); *Darwin in Journ. Linn. Soc.* vi. p. 153, fig. 2 A; *id. Fertiliz. Orch.* ed. 1, p. 239, fig. 28 A; *id. in Ann. Sc. Nat.* sér. 4, xix. p. 247, t. 12. fig. A 3.

Very closely allied to *C. cristatum.* Schomburgk confounded the female of this species with that of *C. tridentatum*, referring all to *Monachanthus viridis*, Lindl. The female (so-called *Monachanthus viridis*) investigated by Darwin also belongs to the present species.

3. Catasetum callosum, *Lindl.*

♂. C. callosum, *Lindl. Bot. Reg.* xxvi. (1840), *Misc.* p. 77; *id.* xxvii. t. 5; *Bot. Mag.* t. 4219 (var. grandiflorum, *Hook.*); *id.* t. 6648.

♀. C. callosum, *Lindl.*; *Reichb. f. in Walp. Ann. Bot.* vi. (1861), p. 577.

4. Catasetum cernuum, *Reichb. f.*

♂. Myanthus cernuus, *Lindl. Bot. Reg.* xviii. (1832), sub t. 1538; *id.* t. 1721; *id. Gen. & Sp. Orch.* p. 155.—Catasetum trifidum, *Hook. Bot. Mag.* lx. (1833), t. 3262.—C. cernuum, *Reichb. f.*, *in Walp. Ann. Bot.* vi. (1860), p. 570; *Bot. Mag.* t. 5399.

♀. Monachanthus viridis, *Lindl. Bot. Reg.* xviii. (1832), sub t. 1538; *id. Gen. & Sp. Orch.* p. 157 (not elsewhere).—Catasetum cernuum, *Reichb. f.*; *Rodr. Gen. et Sp. Orch. Nov.* ii. p. 218 (§ *Monachanthus*).

The female of this species is clearly the original *Monachanthus viridis*, as pointed out at p. 210. Lindley himself afterwards confounded the female of *C. tridentatum* with it, while Schomburgk confounded together both the latter and the female of *C. barbatum*, under the same name. I have only seen the original drawing and a single dried flower, but the so-called "§ *Monachanthus*" form of *Catasetum cernuum*, cited above, is clearly the same.

5. Catasetum cristatum, *Lindl.*

♂. C. cristatum, *Lindl. Bot. Reg.* x. (1824), sub t. 840; *id.* t. 966; Var. monstrosum, *Hook. Ic. Pl.* ii. t. 177 (also ♀).—Myanthus cristatus, *Lindl. Bot. Reg.* xxiii. (1837), t. 1947 A, text 1951* (also ♀).

♀. Monachanthus cristatus, *Lindl. Bot. Reg.* xxiii. (1837), t. 1947 A, text 1951* (also ♂).—Catasetum cristatum, var. monstrosum, *Hook. Icon. Pl.* ii. t. 177 (also ♂).

This species is interesting, as the one in which the occurrence of a second kind of flower in the genus *Catasetum* was first observed, though the significance of the phenomenon was until long afterwards quite unknown. At t. 966 of the 'Botanical Register' (in 1826) Lindley speaks of "a curious monster" which bore, among flowers of the ordinary kind, two or three others in which the labellum was of the same nature as that of *C. tridentatum*.

6. Catasetum Darwinianum, *Rolfe*. (Plate VIII.)

♂. C. Darwinianum, *Rolfe, in Gard. Chron.* ser. 3, v. p. 394. —C. fuliginosum, *Rolfe, in Gard. Chron.* ser. 3, iv. (1887) p. 473 (*non Lindl.*).

♀. C. Darwinianum, *Rolfe, in Gard. Chron.* ser. 3, v. p. 394. —C. fuliginosum, *Rolfe, in Gard. Chron.* ser. 3, iv. (1887), p. 473 (*non Lindl.*).

This is a plant which flowered in the Kew Collection during the autumn of 1888. At the time I identified it with *C. fuliginosum*, Lindl., described from a female specimen only, of which the native country is unknown. But on working up the present paper and comparing the dried specimens side by side, I think the identification erroneous, and have therefore proposed the new name above cited. The plant, which is a native of British Guiana, is represented in the accompanying Plate, for which I am indebted to the Bentham Trustees.

7. CATASETUM DELTOIDEUM, *Lindl.*

♂. Myanthus deltoideus, *Lindl. Bot. Reg.* xxii. (1836), t. 1896; *Bot. Mag.* t. 3923.

♀. Catasetum deltoideum, *Lindl. Bot. Reg.* xxvi. (1840), *Misc.* p. 71.

The female of this has not been figured, but there is an excellent specimen in Lindley's Herbarium.

8. CATASETUM GNOMUS, *Linden & Reichb. f.*

♂. C. Gnomus, *Linden & Reichb. f. ex Reichb. f. Xen. Orch.* ii. (1873), p. 171, t. 170. fig. 5; *Ill. Hort.* xxiv. n. s. t. 270. —C. heteranthum, *Rodr. Gen. et Sp. Orch. Nov.* i. (1877), p. 127 (§ *Myanthus*; also ? § *Catasetum*), et p. 205.

♀. C. heteranthum, *Rodr. Gen et Sp. Orch. Nov.* i. (1877), p. 128 (§ *Monachanthus*), et p. 205.

I have only seen the male of this species, the so-called "§ *Myanthus*" form of Rodrigues. Three distinct forms are pointed out by that author, on which point see remarks, *supra*, pp. 214, 215.

9. CATASETUM MACROCARPUM, *Rich.*

♂. C. macrocarpum, *Rich., ex Kunth, Syn. Pl.* i. (1822) p. 331, in footnote; *Kunth, in Humb. & Bonpl. N. Gen. et Sp.* vii. p. 158, t. 231 (also fruit, with restored female flower); *Warn. & Will. Orch. Alb.* t. 189; *Ill. Hort.* n. s. t. 619. —C. tridentatum, *Hook. Exot. Fl.* ii. (1825), tt. 90, 91; *Bot. Mag.* tt. 2559, 3329; *Lindl. Bot. Reg.* t. 840; *Rchb. Fl. Exot.* i. t. 60; *Schomb. in Trans. Linn. Soc.* xvii. p. 551 (in part); *Darwin, in Journ. Linn. Soc.* vi. p. 152, fig. 1; *id. Fertiliz. Orch.* ed. 1, p. 232, fig. 27; *id. in Ann. Sc. Nat.* sér. 4, xix. p. 247, t. 12. figs. A 1, 2.—C. Claveringii, *Lindl. Bot. Reg.* x. (1824), t. 840; *Lodd. Bot. Cab.* t. 1344; *Reichb. Fl. Exot.* ii. t. 122.—C. floribundum, *Hook. Exot. Fl.* ii. (1825), t. 151.

♀. Monachanthus viridis, *Lindl. Bot. Reg.* xxi. (1836), t. 1752 (not elsewhere).—Catasetum macrocarpum, *Kunth, in Humb. & Bonpl. N. Gen. et Sp.* vii. p. 158, t. 231 (also ♂).

The male plant is very variable, and has received several names. The female is not the original *M. viridis*, though it has been confounded with it and with the females of other species. It is

remarkable that on Kunth's plate, above cited, there is a figure of a female flower attached to the fruit, but, being restored from the withered flower, it is inaccurate in some respects, notably the column and lip, which have clearly been helped out from the male flower. In Lindley's Herbarium is a most interesting specimen, with eight female flowers below and two males at the apex of the raceme.

10. CATASETUM NASO, *Lindl.*

♂. C. Naso, *Lindl. Bot. Reg.* xxix. (1843), *Misc.* p. 71; *id.* xxx., *Misc.* p. 36; *Bot. Mag.* t. 4792.

♀. There is a MS. drawing at Kew of a plant which flowered at Syon House, which shows both sexes of this species. The drawing is unfinished, but a single detached flower of either sex is finished in colours. The male has the petals somewhat resembling the lip in character, though otherwise normal. Underneath is written, "Another apparent var. of *Cat. Naso*—but with remarkable petals." The female is quite normal, and under it is written "*Monachanthus viridis.*" This very drawing is the original of Bot. Mag. t. 4792, but for some reason the female flower is altogether omitted from the plate. Sir William Hooker remarks:—"Drawings of the two kinds of flowers here given .... were submitted to Dr. Lindley, who considers them to be varieties of *C. Naso*; as such we represent them, with a feeling, however, upon our minds that they may all be sports of the original *C. tridentatum.*" I may add that in the published plate all the flowers represented on the raceme are males in the normal condition, and that the detached flower represents a peloriate state of the same, with fimbriate petals, as pointed out above.

11. CATASETUM ŒRSTEDII, *Reichb. f.*

♂. C. Œrstedii, *Reichb. f. in Bonpl.* iii. (1855), p. 218; *id. in Walp. Ann. Bot.* vi. p. 565.

♀. C. Œrstedii, *Reichb. f.*; *Walp. Ann. Bot.* vi. (1861), p. 577.

12. CATASETUM PILEATUM, *Reichb. f.*

♂. C. pileatum, *Reichb. f. in Gard. Chron.* n. s. xvii. p. 492; *id.* xxvi. p. 616; *Sander, Reichenbachia*, ii. p. 91 (also ♀), t. 90.—C. Bungerothii, *N. E. Br. in Lindenia*, ii. (1886),

p. 21, t. 57; *id.* tt. 104 (var. Pottsianum), 116 (var. aureum); *Bot. Mag.* t. 6998; *Warn. & Will. Orch. Alb.* t. 352; *Ill. Hort.* xxxiv. t. 10; *Gard. Chron.* ser. 3, i. p. 139, with plate, p. 142, fig. 32; *N. E. Br. in Gard. Chron.* ser. 3, v. p. 461, fig. 83 A.

♀. C. pileatum, *Reichb. f.*; *Sander, Reichenbachia*, ii. p. 91 (also ♂).—C. Bungerothii, *N. E. Br. in Gard. Chron.* ser. 3, v. p. 461, fig. 83 B; *Rolfe, in Gard. Chron.* ser. 3, vi. p. 466.

A single female flower was produced on the same raceme with those of the other sex during last autumn, in the collection of the Société de l'Horticulture Internationale, at Brussels, and was sent to Kew by M. Lucien Linden, where it is now preserved. It is very distinct in appearance, and could not well be mistaken for any other at present known.

13. Catasetum Regnellii, *Rodr.*

♂. C. Regnellii, *Rodr. Gen. et Sp. Orch. Nov.* ii. (1881), p. 219 (§ *Myanthus*).

♀. C. Regnellii, *Rodr. l. c.* p. 219 (§ *Monachanthus*).

Only known to me by the description, from which it is clear that the two forms described are simply the sexual states of the species.

14. Catasetum sanguineum, *Lindl.*

♂. C. sanguineum, *Lindl. in Paxt. Fl. Gard.* ii. (1851–2), p. 168, fig. 225; *Pescatorea*, i. t. 16.—Myanthus sanguineus, *Linden, ex Lindl. in Paxt. Fl. Gard.* ii. p. 168 (in note).

♀. C. sanguineum, *Lindl.*; *Planch. Hort. Donat.* (1854–8), p. 136; *Reichb. f. in Gard. Chron.* n. s. ix. p. 104.

The female of this species I have not seen, but it is described in the places above cited.

15. Catasetum umbrosum, *Rodr.*

♂. C. umbrosum, *Rodr. Gen. et Sp. Orch. Nov.* i. (1877), p. 129 (§ *Catasetum*).

♀. C. umbrosum, *Rodr. l. c.* p. 129 (§ *Monachanthus*).

Only known to me by the description, from which it is clear the two forms described are the sexual states of the species. The

position of the lip is not mentioned, but from the characters given I believe it belongs to the section *Myanthus*.

16. CATASETUM VARIABILE, *Rodr.*

♂. C. variabile, *Rodr. Gen. et Sp. Orch. Nov.* ii. (1881), p. 217 (§ *Myanthus*).

♀. C. variabile, *Rodr. l. c.* p. 217 (§ *Monachanthus*).

Only known to me by the description, from which it is clear that the two forms described are simply the sexual states of the species.

SUBDIVISIONS OF THE GENUS CATASETUM.

No attempt has hitherto been made to separate the species of *Catasetum* into natural groups; though, with the clearing away of the mystery which has surrounded them and the accumulation of a more complete series of specimens, it is certain that such a subdivision will be not only possible, but absolutely necessary, in order to get something like a clear idea of their relations to each other. There appears to me to be four very distinct sections under which the species may be grouped; and I have not seen a single species of which there can be any doubt as to its position. The second group, however, *Myanthus*, absorbs the majority of the species. The following list only includes some of the better known species, and is not intended to be exhaustive.

Section I. EUCATASETUM.—Diœcious; lip superior in both sexes, generally more or less galeate in the male, always so (as far as known) in the female; rostellum prolonged below into a pair of slender cirrhi, the antennæ, one of which is generally curved forward in front of the column and sensitive, the other curved round near its base and functionless.

To this section belongs *C. macrocarpum*, Rich., on which the genus was founded, and some nine or ten others, at least. The following species, and perhaps a few others, belong to the group:—

C. ATRATUM, *Lindl.*
C. GNOMUS, *Linden & Reichb. f.*
C. MACROCARPUM, *Rich.*

} See preceding list.

C. MACROGLOSSUM, *Reichb. f.*

C. MACULATUM, *Kunth* (C. integerrimum, *Hook.*, C. Wailesii, *Hook.*).

C. NASO, *Lindl.*
C. ŒRSTEDII, *Reichb. f.* } See preceding list.

C. PLANICEPS, *Lindl.* (C. recurvatum, *Link, Klotzsch, & Otto*).

C. PURUM, *Nees* (C. semiapertum, *Hook.*).

C. VIRIDIFLAVUM, *Hook.* (C. serratum, *Lindl.*).

In some of the species one of the antennæ stands forward in front of the other, and the hinder one is usually, perhaps invariably, functionless, as pointed out by Darwin in similar instances; in others both are in the same plane and equally sensitive. The same character appears in certain species of the succeeding section, so that the superior lip of the male flower is the essential distinguishing character of the present group.

Section II. MYANTHUS.—Diœcious; lip inferior in the male, generally much flatter than in *Eucatasetum*, superior in the female, and galeate; rostellum prolonged below into a pair of slender antennæ, which are either in different planes, and one of them functionless, as in *Eucatasetum*, or both stand forward in the same plane, over the lip, and are equally sensitive.

It is a large group, comprising between thirty and forty described species. The position of the antennæ appears to offer the best primary character for its subdivision, after which the shape of the lip serves to distinguish two or three fairly natural groups of species.

Antennæ in different planes, one only sensitive.

C. PILEATUM, *Reichb. f.* See preceding list.

C. CHRISTYANUM, *Reichb. f.*

C. LAMINATUM, *Lindl.*

C. SACCATUM, *Lindl.*

C. TABULARE, *Lindl.*

Antennæ in same plane, both sensitive.

C. BARBATUM, *Lindl.*
C. CALLOSUM, *Lindl.*
C. CERNUUM, *Reichb. f.*
C. CRISTATUM, *Lindl.*
C. DARWINIANUM, *Rolfe.*
C. DELTOIDEUM, *Lindl.*
See preceding list.
C. GARNETTIANUM, *Rolfe.*
C. LURIDUM, *Lindl.*
C. SANGUINEUM, *Lindl.* See preceding list.
C. TRULLA, *Lindl.*

Both these groups, but especially the latter, contain other species, but in most cases the material to hand is insufficient for satisfactory determination.

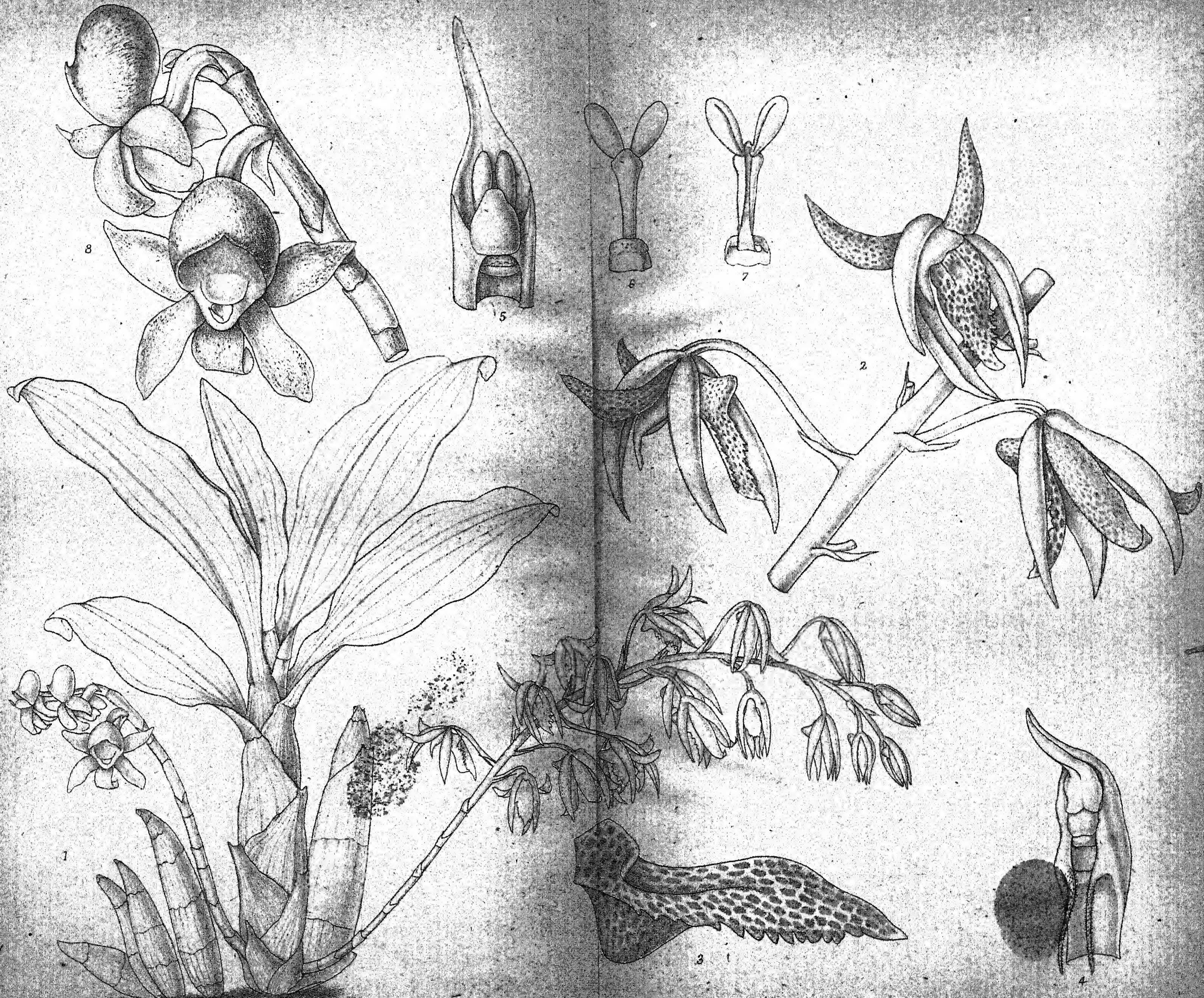
Section III. ECIRROSÆ.—Diœcious; lip inferior in the male, as in *Myanthus*, but the column without the antennæ-like prolongations of the rostellum; female at present unknown.

A remarkable little group of about eight described species, as follows:—

C. CALCEOLATUM, *Lem.*
C. GLAUCOGLOSSUM, *Reichb. f.*
C. ROSEUM, *Reichb. f.*
C. RUSSELLIANUM, *Hook.*
C. SCURRA, *Reichb. f.*
C. THYLACIOCHILUM, *Lem.*
C. VIOLASCENS, *Reichb. f. et Warscew.*
C. WARSCEWICZII, *Lindl.*

Section IV. PSEUDO-CATASETUM.—Hermaphrodite; lip inferior, saccate; column short and stout, without cirrhi.

This group is remarkable on account of its hermaphrodite flowers, which, however, do not appear to differ in any other essential point of structure; while the habit of the species is



M. Smith del.
R. Morgan, lith.

West, Newman imp.

CATASETUM DARWINIANUM, Rolfe.

precisely identical with those of the preceding sections. Although I was able to examine living flowers, I could not satisfy myself whether any portion of the column was sensitive. I touched it in several places, somewhat roughly at last, but without producing the slightest effect. But when at length I brought the anther-case away by force the stipes of the pollinia was seen to be curved round a protuberance on the face of the column, and being liberated it immediately straightened itself; and I suspect that when the flowers are in the proper state of maturity the function of this elasticity is to help in ejecting the pollinia. Here is a case for future observation; but I have noticed in one or two instances in the preceding sections that the flowers are not equally sensitive at all times. Whether this depends upon the proper stage of maturity being reached, or upon the temperature, or whether it is that some species are more sensitive than others, I do not at present feel satisfied about. Further observations are necessary to decide the point.

The following species belong to this section :—

C. CASSIDEUM, *Linden & Reichb. f.*

C. DISCOLOR, *Lindl.* (Monachanthus discolor, *Lindl.*, M. fimbriatus, *Gardn.*, M. Bushnani, *Hook.*, C. roseo-album, *Hook.*).

C. LONGIFOLIUM, *Lindl.*

DESCRIPTION OF PLATE VIII.

Fig. 1. Plant, showing the male and female inflorescences on either side of the same pseudo-bulb ; $\frac{1}{3}$ nat. size.
2. A portion of male inflorescence; nat. size.
3. Lip of male ; $\times$ 2 diam.
4. Column of ditto, showing the antennæ ; $\times$ 2 diam.
5. Anther-case, front view ; $\times$ 3 diam.
6. Pollinia, with stipes and gland, back view ; $\times$ 2 diam.
7. The same, front view ; $\times$ 2 diam.
8. A portion of female inflorescence ; nat. size.

Review of some Points in the Comparative Morphology, Anatomy, and Life-History of the *Coniferæ*. By Maxwell T. Masters, M.D., F.R.S., V.P.L.S., Corr. Memb. Instit. France.

[Read 18th April, 1889.]

Introduction.

The following review is the outcome of personal observation and research carried on at intervals during several years.

The observations have, for the most part, been made upon living plants and fresh specimens. The living examples have been studied in the Royal Gardens, Kew, and in numerous pineta, gardens, nurseries, and plantations throughout the country. Moreover, I have myself had under cultivation from the seedling to the adolescent stage a large number of species and varieties, which have thus been under more or less continuous observation for some years.

Numerous specimens have been obligingly sent to me from various botanic gardens, such as Edinburgh, Glasnevin, Cambridge, and from the rich experimental garden at Antibes presided over by M. Naudin. Native specimens have also been procured from Australia through the kindness of Baron Sir Ferdinand von Mueller, from New Zealand by the courtesy of Dr. T. Kirk and Mr. Hamilton, from America, from Spain, Portugal, Italy, and France, and some have been collected by myself in Switzerland.

I am prevented by considerations of space alone from acknowledging separately the assistance I have received from proprietors, gardeners, and nurserymen.

For much assistance in the matter of microscopical illustrations I am indebted to Mr. Nicholson and to Mr. Reed, and I have also availed myself of the excellent series of sections made to illustrate American Conifers by Dr. King.

In addition to the fresh specimens I have made use of the materials in the London herbaria, and have controlled and extended the observations made upon the living or cultivated plants by the comparison of the wild ones as represented in the herbaria.

The illustrations are mostly from original sketches, and several are taken from the 'Gardeners' Chronicle,' to the proprietors of which Journal I am indebted for their use.

The extensive literature, and especially the pictorial illustrations, of the order have also been systematically referred to.

The main object of the investigation has been to gain a general and comparative view of the external morphology of the whole order, to ascertain, so far as possible, the causes and conditions inducing the development of particular forms or modes of growth, and to enquire into the purposes served by the numerous variations and presumed adaptations.

The comparative histology of root, stem, and leaf is only incidentally alluded to, as these subjects are treated of in the works of Bertrand, De Bary, and Van Tieghem, which are frequently cited.

Classification, or the study of the origin, lineage, and relationships of species and other groups, has also not been a primary object of investigation, although it has been constantly kept in view and the importance of certain characters as a means of discriminating between one species and another is duly noted. It may here be stated that I have followed, for the most part, the arrangement and limitations proposed by Bentham and Hooker and by Parlatore; but, not being concerned in the present paper with the accurate nomenclature and synonymy of species, I have taken the names as I found them in gardens or in books, only correcting obvious errors, but without in all cases verifying (or having the means to verify) the assigned names.

Various contested points in the morphology of the order, such as the nature of the needles of *Sciadopitys* and of *Pinus*, and the constitution of the flowers, male and female, have been dealt with in more or less detail, but no attempt has been made to enter upon the question of Gymnospermy, the correctness of which is throughout assumed, nor to investigate the minute structure of the nucellus and its developments in the shape of archegonia and their relationship to similar productions among the higher Cryptogams. These matters are only incidentally alluded to, not, indeed, from any want of appreciation of their extreme importance in illustration of the lineage and descent of the plants in question, but from a personal lack of the requisite conditions for their efficient study.

The "characters" presented by Conifers, as by other plants, are partly the outcome of hereditary transmission and of survival in a comparatively unchanged condition. Partly also they are acquired or assumed in response to some influence from whose

power there is no escape short of gradual extinction. These latter are adaptive and serve, or have served, some useful purpose. Thus the nature of the root depends upon the conditions of the medium in which it grows; the direction of the branches, and the arrangement, structure, and movements of the leaves are clearly in relation with the varying intensity and changing direction of the light. Other modifications have reference either to the protection or to the dispersal of the pollen or to similar requirements in the case of the embryo and seed. These and like matters are kept in view throughout the following pages.

The observed changes are, as universally the case, brought about by variations in the intensity of growth and development, as by an arrest, excess, or perversion of growth and by similar conditions of development. Growth is here understood to be mere increase in bulk without attendant differentiation, while development implies progressive or regressive change—greater or less differentiation. Changes in the one process are often, but not necessarily always, associated with corresponding diversity in the other. Any particular change in one direction is pretty sure to be accompanied by co-relative changes in others. The changes in question may be continuous and uniform or they may be interrupted for a time to be afterwards resumed. These several mutations and rhythmical alternations bring about manifold or pleiomorphic conditions, which in the case of the Coniferæ are very remarkable. One such illustration may here be given in the case of the shoots of *Pinus* from the bud-stage to the fully developed state. In the unopened bud we have an illustration of arrested growth and development in the case of the bud-scales; the central axis is also for the time arrested in its growth, the arrest being followed, in response to the stimulus of augmented heat, by rapid elongation, and by the corresponding development of the secondary leaves. In the male inflorescence there is also arrested development manifested in the enveloping bud-scales, followed in due course by the elongation of the axis and the differentiation of the tissues of the leaves into sporophylls or anthers. In the female flower there is similar arrested development in the environing scales, and generally speaking a relatively low degree of differentiation in the bracts. These are serially continuous with, and obviously homologous with the leaves. The fruit-scales within the bracts present some remarkable illustrations both of arrest and, so to speak, of

perverted differentiation and which are alluded to under their respective headings.

To show the diversity in appearance which may be met with in one member—the leaf—Engelmann points out that in *Pinus* seven different forms of leaves occur, as hereafter mentioned in detail. Certain of these forms of leaf occur on the same plant at different periods, being characteristic either of youth or of temporary and intermittent accessions or relaxations of growth. In other cases a certain degree of permanence of a particular form of branch or leaf is observable. Mention is made of these cases under the head of ramification and foliage, and especially with reference to the Serpent-firs (*Abies excelsa*, vars. *monstrosa* and *viminalis*) and to the Retinosporas of gardens.

The Retinosporas have been considered to form a distinct genus, and are so described in various works of authority. They represent, however, only various "stadia" in the life-history of certain species of *Thuya*, of *Chamæcyparis*, or of *Juniperus*. These plants, under cultivation, continue year after year to produce one description of foliage only, and so may very readily be mistaken for separate species. *Thuya pisifera* thus exists under three or even four distinct conditions; and if the clue were not afforded by some "happy accident," such as the occasional presence of two or more forms on the same bush, all four forms might be considered as so many species, a fact not to be lost sight of in the identification of fossil plants. The forms in question are, as has been said, more or less persistent. Why, then, under favourable conditions should they not remain completely so? May we not, in fact, have, as Caspary suggested in the case of the Snake-fir, the beginning of a new species? And may we not, especially in such instances as the Retinosporas, be lookers-on at the origin of forms which will gradually become stable enough to constitute species? The supposition is rendered the more plausible in that the variations in question are in some cases perpetuated by seed. The larger proportion of seedlings from such plants doubtless revert to the typical stock; but a considerable proportion perpetuate the variety. The cultivator, by the constant elimination of some forms, and by the continuous protection of others, succeeds at length in "fixing" certain desired varieties.

Doubtless a similar process occurs in Nature; and in watching the morphological changes that occur in plants, we are certainly witnesses, on the one hand, of the permanence characteristic

of hereditary endowment or of reversion to an ancestral state, and, on the other, of the changes resulting in adaptation to varying circumstances; and, lastly, we may be present as on-lookers, and even as gardeners are sometimes privileged to be actual assistants at the birth and development of new species. Whether, however, the phenomena witnessed in the so-called Retinosporas are survivals and vestiges of a former condition, or whether they are the results of attempts to conform to new conditions, which will ultimately result in "new species," is a matter that cannot be stated with any certainty. Those appearances in the adult plant which reproduce the characteristics of the seedling may be due to reversion, but others may be instances of progressive adaptation.

The Seedling Plant.

The characteristics presented in the process of germination and by the seedling plant during its growth do not differ materially from those of flowering plants generally. Nevertheless, there is a good deal of variation in minor points in different genera. Thus it is, in general, easy to distinguish a seedling *Abies* from a seedling *Picea*, and both from a *Pinus*; hence the desirability, for purposes of discrimination, of taking note of the differences which the seedling plants present.

The investigation of the characteristics of seedlings derives further interest from the relation they bear to the supposed ancestral condition of the plants, from their bearing on the varying physiological requirements of the young plant, and on their power of adaptation to particular external circumstances.

It is, however, requisite to exercise much caution in these matters, as it occasionally happens that in different species of the same genus different modes of germination occur, as, for instance, in the genus *Araucaria*, where, in some species, the cotyledons are hypogeal and with a fleshy tigellum, epigeal in others. The lobing of the cotyledons in *Pinus* or the variable number of the seed-leaves may be indications of varying degrees of energy of growth, rather than of direct hereditary transmission.

Germination.—The germination of the seed presents no very special features; the husk of the seed splits into two pieces or irregularly, the radicle protrudes, descends into the soil, while the tigellum or caulicle lengthens often to a considerable extent, bearing at its summit the cotyledons still enclosed within the husk till at length, by the arching of the upper end of the

tigellum, and by the tension exercised by the growing cotyledons, the husk is thrown off.

The mode of germination is still unknown in many species. I have had the opportunity, thanks to the assistance of the Director and the Curator of the Royal Gardens, Kew, of examining a large number of species; and for a general statement of the observed phenomena reference may be made to the works of L. C. Richard *, Gœppert †, and to the *résumé* to be found in Sachs's Text-book ‡, or Goebel §.

An investigation of the characters of the seedling plant is important not only as occasionally furnishing a means of discrimination, but also as showing vestiges of what has been, and as affording forecasts of what will be.

The Radicle.—The monopodial radicle is usually slender and tap-shaped, its branches being arranged in two ranks, and given off generally nearly at right angles to the main axis, even in cases where they subsequently descend. The fibrils are often contorted, even when the soil they penetrate is light and open.

The Root.—There are considerable differences in the depth to which the tap-roots penetrate, and in the extent and direction of their ramifications, dependent mainly on the character of the soil and the other conditions under which the plants are growing; though in other cases this direct relationship is not so obvious. Thus, in *Pinus silvestris, austriaca, rigida, insignis*, in *Picea excelsa, Sequoia gigantea, Cedrus Deodara*, and *C. atlantica* the main root descends more or less vertically, while the branches spread nearly horizontally. In *Pinus Laricio, ponderosa, Abies Pinsapo, Pseudotsuga Douglasii, Thuya gigantea*, and *Cupressus Lawsoniana* the secondary roots have a downward direction. In *Tsuga Mertensiana* there is less difference in size between the primary and the secondary root-branches than in the Pines; the root, in fact, is more bushy, and the secondary branches go obliquely downwards. In *Taxodium distichum* the primary root is relatively extremely long, bright red, with a very few branches which are directed obliquely downwards. As compared with the Deodar (*Cedrus Deodara*), *Cedrus atlantica* has a more compact, less-spreading root-system with the secondary branches shorter. The cortex of

* L. C. Richard, 'Comm. Bot. de Conif.' (1826).
† Gœppert, 'De Conif. Structura Anatomica' (1841).
‡ Sachs's 'Text-book,' ed. Vines (1882), p. 508.
§ Goebel, 'Outlines of Classification, &c.' (1887), p. 220.

the radicle of the Deodar is of a grey colour, that of *C. atlantica* red. Whether these appearances, observed in a small number of cases only, are invariable, may well be doubted.

M. Van Tieghem draws attention to the means whereby the radicle of some Conifers (excluding the Abietineæ) is strengthened and enabled to resist the strains to which it is subjected*. This is effected by the formation of thickenings in the constituent cells of one of the cortical layers next to the endoderm. These thickened cells are peculiar to the root and are not seen in the caulicle †.

The Caulicle.—The caulicle ‡ is generally erect, slender, of considerable length to raise the cotyledons above the surrounding herbage, and of course destitute of branches or rootlets.

The colour of the bark of the adult tree is often foreshadowed in the colour of the rind of the caulicle. In *Cephalotaxus* and in some species of *Araucaria*, as in *A. Bidwillii* and *A. imbricata*, the caulicle is carrot-shaped, very thick and fleshy, thus serving as a reservoir of nutriment for the young plant.

The Cotyledons.—The most noteworthy points with reference to these organs are the hypo- and epigeal conditions respectively. Where the cotyledons do not appear above ground, or are not much raised above its surface, they are generally thick and fleshy in texture, and do not readily disengage themselves from the seed-coat (see figs. 1, 2, 3). They contain much nutritive matter available for the growing plant. Cotyledons of this character are met with in the tribe Taxeæ in *Cephalotaxus* and *Ginkgo*, and in the section *Columbea* of the genus *Araucaria*. The cotyledons of *Ginkgo* are thick, fleshy, oblong, constricted at the base into short stalks which in germination protrude in an arching direction, leaving the body of the seed enclosed within the shell. The plumule

* P. Van Tieghem in Ann. Sc. Nat. sér. 7, tom. vii. p. 374 (1888), "Sur le réseau de soutien de l'écorce de la racine;" and Ann. Sc. Nat. (1871), t. xiii. p. 187.

† P. A. Dangeard, in a paper published since this communication was read. and entitled "La mode d'union de la tige, et de la racine chez les Gymnospermes," Comptes Rendus, Feb. 1890, asserts that if there are two cotyledons there are two woody bundles in the root alternating with two liber-bundles; if three cotyledons, the number of bundles corresponds; but if there is a greater number of cotyledons, the number of bundles in the root does not correspond.

‡ The word "hypocotyl" has of late years been introduced to denote what was formerly called the caulicle or the tigellum; but as there appears to be no special advantage in departing from the rule of priority, and in adding a synonym to an overburdened terminology, I adhere to the old usage.

above the cotyledons is 3-sided, bearing tristichous leaves of an oblong form, gradually passing into the wedge-shaped form which characterizes the adult plant.

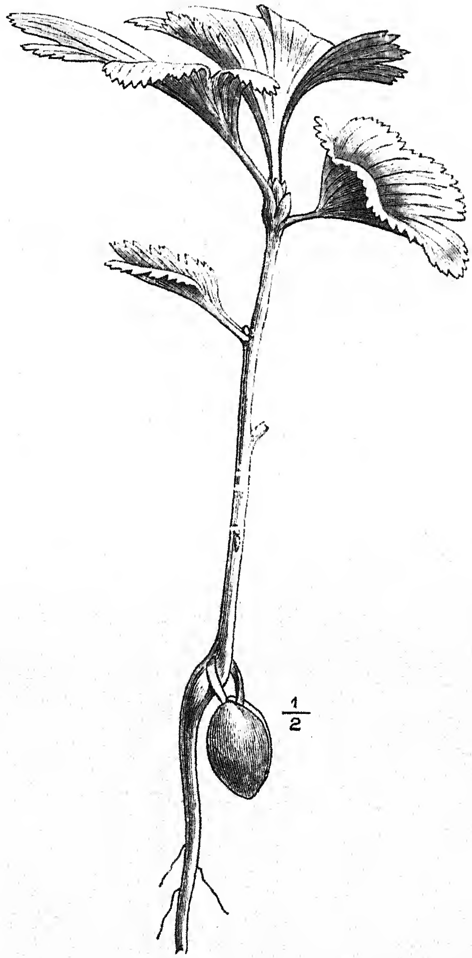


Fig. 1.—Seedling plant of *Ginkgo*, drawn by Mr. Weathers.

The mode of germination in different species of *Araucaria* varies so much that authors have founded subdivisions of the genus upon these differences; thus in the American species belonging to the section *Columbea* there are but two cotyledons, and these hypogeal, as in *A. Bidwillii* and *A. imbricata*. In

these species the caulicle is thick and fusiform. In the section *Eutassa* the cotyledons are four in number, leafy and epigeal, and

Fig. 2.—Germination of *Araucaria imbricata*; early stage, cotyledons enclosed within the seed, plumule commencing to protrude.

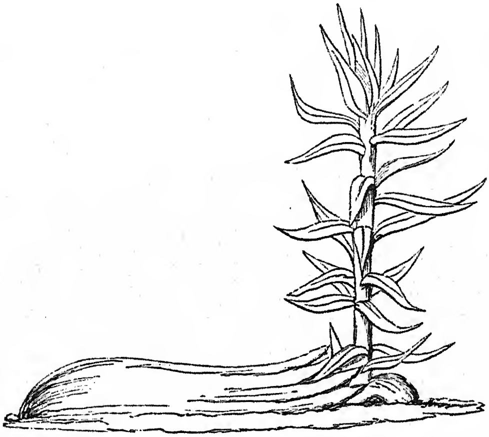


Fig. 3.—Germinating plant of *Araucaria imbricata*, in a further stage of development, showing hypogeal cotyledons, erect plumule, and primordial leaves similar in form and arrangement to the adult ones.

are raised upon a well-marked caulicle, as in *A. excelsa*, *A. Cookii*, *A. Cunninghami* and *A. Cuninghami glauca*. Bentham, however, remarks that the number of cotyledons varies in the same species *. We have here, then, illustrations of the fact that very conspicuous characters, and such, as in the case of the hypo- and epigeal cotyledons, are of great physiological significance, may be of relatively little value for classificatory purposes, inasmuch as species of the same genus may present variations in these respects.

In those cases where the cotyledons are epigeal and leafy in character, the chief points of distinction lie in their number, which may be two or more. Species with two cotyledons are usually very constant in this respect, it being very rare in such plants to

* Bentham in Benth. et Hook. f. Gen. Plant. iii. p. 437.

find seedlings with more than two; but when the number is increased, much irregularity as to number prevails. Duchartre*, adopting the opinion of Adanson† and of A. L. de Jussieu ‡, in opposition to the views of Gaertner §, Salisbury ||, and L. C. Richard ¶, considered that the multiplicity of cotyledons was more apparent than real, and might be traced to the subdivision of two. If, however, the vascular bundles be traced from the caulicle, it will be seen that the vascular cylinder breaks up, not first into two divisions which subsequently branch, but into a variable number, not always in direct relation to the number of the cotyledons.

The following genera and subgenera are known to have two or more cotyledons. Those genera to which the sign ! is appended have been examined by myself.

Embryo dicotyledonous.

Tribe *Cupressineæ.*
Callitris !, Frenela !, Actinostrobus, Fitzroya, Libocedrus, Thuya !, Cupressus ! (including C. Lawsoniana !), Juniperus !, Retinospora !

Tribe *Taxodieæ.*
Cryptomeria !, Taxodium ?, Athrotaxis !, Sciadopitys !.

Tribe *Taxeæ.*
Taxus !, Torreya !, Ginkgo !, Cephalotaxus !, Phyllocladus !, Dacrdium !, Pherosphæra.

Tribe *Podocarpeæ.*
Microcachrys, Saxe-Gothæa, Podocarpus !

Tribe *Araucarieæ.*
Cunninghamia, Agathis !, Araucaria !

Embryo polycotyledonous.

Tribe *Cupressineæ.*
Callitris spp. !, Cupressus spp. !, Juniperus spp. !

Tribe *Taxodieæ.*
Sequoia, Cryptomeria (subinde) !

Tribe *Araucarieæ.*
Araucaria spp. !

* Duchartre in Ann. Sc. Nat. sér. 3 (1848), x. p. 207.

† Adanson, 'Familles,' p. 305, "le pin n'a réellement que deux cotylédons."

‡ A. L. de Jussieu, 'Gen. Plant.' ed. 2, Præf. p. xviii, & p. 415.

§ Gaertner, 'De Fruct. et Sem.' p. 157 (1788).

|| Salisbury in Trans. Linn. Soc. viii. (1807), p. 311.

¶ Richard, Comm. Bot. de Conif. (1826).

Tribe *Abietineæ.*

Pinus !, Cedrus !, Picea (*Link*) !, Tsuga !, Pseudotsuga !, Abies (*Link*) !, Larix !

The following list, in which are incorporated the records of Gœppert and of Engelmann, together with my own, will show how variable is the number of cotyledons when more than two, even in different individuals of the same species.

Abies

apollinis 7, balsamea 4–5, cephalonica 4–6, grandis 6, pectinata 3-7, nobilis 6–8, Pinsapo 6–7, sachalinensis 4–5, sibirica 3–7, Webbiana 4, Veitchii 4–5.

Araucaria spp. 2–4.

Callitris sp. 2–4.

Cedrus

atlantica 9, Deodara 11, Libani 6–9–11.

Cryptomeria

japonica 2–3.

Cunninghamia

sinensis 3.

Cupressus

glauca 3-4–6, globularis (*Hort. Palermo*) 2, pendula 3, pyramidalis 3, retrofracta (?) 2.

Keteleeria

Davidiana 2.

Larix

europæa 5–7, Griffithii 5–7, microcarpa 4–5, sibirica 4–5.

Picea

excelsa 3-8, Menziesii 5–6, orientalis 9–11.

Pinus

aristata 6–8, australis 7–10, austriaca 3–6–8, Ayacuite 12–15, Balfouriana 5, Banksiana 4–5, Bungeana 11, calabrica 8, canariensis 6–7–8, Cembra 8–14, cembroides 9–12, cephalonica 5–8, cilicica 8, Coulteri 10–14, edulis 7–10, Elliottii 6–9, excelsa 8–12, flexilis 8–9, Gerardiana 3–6–8, glabra 5–6, halepensis, 6, 7, 8, 9, inops 4–6, insignis 6–9, Jeffreyi 10, Lambertiana 12–15, Laricio 4, 6–8, maderensis (?) 10, maritima 6–8, Massoniana (?) 6, mitis 4–7, monophylla 7–10, monspeliensis 7–9, monticola 6–9, montana 3-6, palustris 9, parviflora 8–10, Parryana 8, Peuke 9–10, Pinaster 5–8, Pinea 8–14, Pithyusa 8, ponderosa 6–11, pungens 7–8, resinosa 6–7, rigida 5, Sabiniana 12-18, silvestris 3–6–8, Strobus 7–14, Tæda 5–8, Torreyana 13–14, tuberculata 5–8.

Pseudotsuga

Douglasii 5–6–7.

Sequoia
  gigantea 4–5.
Tsuga
  canadensis 4.

It is possible that an increased number of cotyledons might, under certain circumstances, be advantageous by securing a larger surface and a better chance in the competition with neighbouring herbage.

The size of the cotyledons also varies greatly in different species. In *Pinus Pinea*, for instance, they are 2 inches long and proportionately stout; while in *P. canariensis* they are equally long, but slender. The relative length of the cotyledons and of the primordial leaves which follow them may afford diagnostic characters; thus, in some species of *Abies*, *Pinus*, *Larix*, *Cedrus*, and *Athrotaxis* the cotyledons are longer than the primordial leaves, while in some species of *Thuya*, *Cupressus*, &c. the cotyledons are of about the same length as the succeeding leaves.

In form the cotyledons are usually linear or linear-oblong, rarely broader as in *Retinospora* (i. e. *Thuya*) *obtusa*, *pisifera*, *Cryptomeria Lobbi*, and *Thuya gigantea.* They are flat or rounded on both surfaces. In some cases the midrib is not prominent; in others, as in *Abies Veitchii*, *sachalinensis*, *balsamea*, *cephalonica*, and *Apollinis*, the midrib is prominent on the upper surface. In many of the species of *Pinus* the cotyledons are 3-sided, one side being anterior or inferior, the other two lateral as regards the axis. The margins are usually entire; but they may be hairy, and in *Pinus Strobus* they are distinctly toothed at the margins. Sometimes they are acute, or even mucronate at the apex, as in many species of *Pinus*; while in *Abies* they are sometimes obtuse and even emarginate, as in *Abies balsamea*, *sibirica*, and *Webbiana.* In *Picea excelsa* they are thickened at the base, and thus afford indications of the peculiar "pulvini" that are so characteristic of the adult branches in that genus.

Anatomy.—A few incidental remarks may here be given, with a view to call attention to the importance of the subject in its relation to physiology, and, as will be more fully exemplified in the case of the leaves, to the investigation of natural affinities.

The fibro-vascular axis of the caulicle forms a cylinder between

the cortical and the central cellular tissue, and is usually undivided for its whole length, breaking up only at the point of emergence of the cotyledons to send branches to those organs. In *Araucaria* the vascular cylinder of the root is unbroken; but in the fleshy tap-shaped caulicle it divides into four wedge-shaped masses with the xylem pointing towards the central pith. A section made at the point of emergence of the cotyledons shows four median bundles at right angles to the cotyledons. Above the cotyledons the bundles are increased to six disposed in a circle, while higher still they form a continuous cylinder. The parenchyma of the ground-tissue in the caulicle is crowded with starch-grains of different sizes; and between the cortex and the vascular ring it is traversed by a number of resin-canals disposed in a circle, or rather ellipse, around the vascular ring; another circle of resin-canals lies just beneath the cortex.

In a species of *Cupressus* with rather thick cotyledons, the structure comprised one layer of brick-shaped epidermal cells, but no hypoderm. Beneath the epidermis on the upper surface only a single layer of palisade-cells was seen densely filled with chlorophyll. The central tissue consisted of loose parenchyma with spheroidal cells, for the most part destitute of chlorophyll. The central fibro-vascular bundle was, in section, transversely oblong, with a well-marked endoderm enclosing the xylem and the phloem, the latter directed, as in perfect leaves, towards the lower surface, the xylem in the opposite direction. In *Pinus canariensis* the three-sided cotyledons have a papular epithelium, no hypoderm, a mesophyll of sphæroid or polygonal cells of uniform character, but differing in size, the inner ones being the largest. There is a single fibro-vascular bundle surrounded by an imperfectly developed endoderm. The structure of the cotyledon of *P. Pinea* is essentially the same. The peculiarities seem to reside in the papular epidermis (epithelium), the absence or imperfect development of hypoderm, and the absence of the sinuous cells which are so marked a feature of the mesophyll of the perfect leaves of the true Pines.

Lestiboudois, in his 'Phyllotaxie Anatomique,' points out the frequent want of concordance between the number of the vascular bundles of the tigellum and the number of the cotyledons. Although there are numerous variations, the normal position of the bundles is in the intervals between the cotyledons.

In *Pinus* the general rule is to have twice as many cotyledons as there are vascular bundles in the caulicle, two cotyledons being placed in the intervals between the primary bundles: thus, supposing there are five bundles, as in *Pinus Pinea*, each bundle divides into two, each division extending into a cotyledon. *P. canariensis*, according to Lestiboudois, has four bundles and eight cotyledons, *P. Strobus* three bundles and nine cotyledons, *P. palustris* seven bundles and nine cotyledons, *P. maritima* five bundles and six to nine cotyledons, *P. Laricio* four bundles and six cotyledons, or five bundles and six to eight cotyledons, *P. calabrica* five bundles and eight cotyledons, *P. monspeliensis* four bundles and seven to nine cotyledons, *P. excelsa* five bundles and twelve cotyledons; *Cedrus* four bundles and eleven cotyledon, the variations in number being due either to subdivision of the bundles, or to the opposite condition of inseparation *.

In some cases where there are two cotyledons there are, according to Van Tieghem, two fibro-vascular bundles in the central cylinder of the root, each of which ramifies indefinitely in the median plane of the cotyledon, while in the polycotyledonous genera the number of fibro-vascular bundles varies even in different individuals of the same species without, however, corresponding to the number of the cotyledons †.

The stomata on the cotyledons vary greatly in number; they are usually oval, with two-guard cells. As to their position, it is noteworthy that they often occur on the upper surface, or on the lateral faces where the cotyledons are three-sided, even in cases where in the adult leaves they are placed on the lower surface. In many species of *Pinus* and in *Picea Menziesii*, where the cotyledons are three-sided, the stomata are almost exclusively on the two lateral surfaces, the dorsal or anterior surface being nearly, if not quite, destitute of them. The same relative position of the stomata occurs in the adult leaves of these plants in some Junipers, *Picea ajanensis*, &c.

* Lestiboudois in Ann. Sc. Nat. sér. 3 (1848), p. 23, t. x.

† Van Tieghem, 'Traité de Botanique' (1884), p. 1323. For fuller details consult De Bary, 'Comparative Anatomy of the Vegetative Organs of Phanerogams and Ferns,' ed. Bower and Scott (1884), pp. 245, 356, 386. Gœppert, 'De seminum germinatione in De Coniferarum Structura Anatomica' (1841). Lately Messrs. Van Tieghem and Douliot have shown that in all Gymnosperms, as in Angiosperms, the radicels come wholly from the pericycle, and are furnished with a root-cap.

This position of the stomates on the upper or lateral surfaces of the cotyledons has been specially observed by the writer in *Pseudotsuga Douglasii*, *Abies grandis*, *balsamea*, *cephalonica*, *Apollinis*, *sachalinensis*, *sibirica*, *Veitchii*, *Cedrus atlantica*, *Libani*, *Cryptomeria Lobbi*, *Cupressus Lawsoniana*, *sempervirens*, *funebris*, *Pinus Jeffreyi*, *Retinospora pisifera*, and *Thuya gigantea*. Engelmann* notes that in *Sciadopitys* the stomates are placed on the lower surface of the cotyledons exclusively.

Plumule.—The term plumule is not very accurately defined. For our present purpose we may take it to be that portion of the axis with its attendant leaves which is formed in the embryo plant prior to germination above the cotyledons. Sometimes it remains in the same condition as when first formed; but generally it undergoes changes in size, &c., during and after germination. The leaves which it produces are often different from those formed on the other parts of the stem. Growth in the plumule is for a time continuous, or at least relatively so; so that sometimes no definite limit can be observed between it and the succeeding portion of the axis. At other times plumular growth is arrested by the formation of a terminal bud invested by perular scales, as I have observed in *Pinus silvestris*, *Pseudotsuga Douglasii*, *Abies pectinata*, *sibirica*, *cephalonica*, *Picea orientalis*, and *P. Menziesii*. How far this is a congenital character, or to what extent it is due to external conditions, is uncertain. In *Gingko biloba* there is a gradual transition between the perulæ and petiolar expansions to perfect leaves. Sometimes the axis above the cotyledons lengthens before it produces any leaves, and then, of course, the plumular or primordial leaves are removed from the cotyledons by internodes. In other cases, as in *Cephalotaxus Fortunei*, *Retinospora pisifera*, *R. obtusa*, *Thuya gigantea*, *Cupressus sempervirens*, *C. Lawsoniana*, *C. funebris*, and *C. macrocarpa*, the first two leaves are close to the cotyledons and decussate with them, while the subsequent pairs of leaves may be separated by internodes. In other cases, again, the primordial leaves are so crowded that they may be called tufted, as has been observed by the writer in *Frenela*, *Larix*, various species of *Pinus*, *Retinospora obtusa*, *Picea orientalis*, *Thuya gigantea*, *Pseudotsuga Douglasii*, *Abies cephalonica*, *grandis*, *sibirica*, and *Apollinis* species in which, as before stated, a true scaly winter-

* 'Revision of the Genus *Pinus*,' p. 3.

bud marks the termination of the first stage of growth. When the axis lengthens, the primordial leaves, instead of being tufted are either scattered as in *Sequoia gigantea*, where they are alternate, or arranged in decussate pairs, each pair being separated by an internode from that above and that below, as in *Sciadopitys*, *Taxus*, *Ginkgo*, *Cupressus*, *Callitris*, *Frenela*, *Araucaria* spp., *Libocedrus*, *Cedrus*, *Phyllocladus*, *Thuya*, *Picea Menziesii*, and *Cryptomeria*. In some of these plants axillary buds may be seen in the axils of the primordial leaves, the first two leaves of these buds being placed at right angles to the primordial leaf. The upper part of the plumule in *Pinus Torreyana* and *Retinospora pisifera* is conoid, compressed from front to back, and depressed at the apex owing to the projection on either side of a leaf-tubercle *.

In a specimen of *Cephalotaxus Fortunei* in the Kew Museum, above the cotyledons and in close proximity to them is a pair of opposite leaves followed after an interval by a whorl of four linear leaves rather larger than the preceding, then after another interspace occur two leaves succeeded in a decussate manner by two others. In this plant the plumule emerges from the seed before the cotyledons are disengaged from the seed-coat. The primordial leaves are either free at the base, as in *Retinospora obtusa*, &c., or concrescent † with the stem and uplifted with it, as in *Cupressus sempervirens*, *Abies Veitchii*, and *Cryptomeria japonica*.

These observations relating to the seedling plant have necessarily been made on a limited number of examples; care must therefore be exercised in drawing inferences from them, the more so as some of the peculiarities mentioned are manifestations of relative degrees of vigour dependent on external conditions ‡.

* Dingler, as cited in the 'Botanical Gazette,' May 1883, p. 229, asserts that in seedling Gymnosperms there is, as in Cryptogams, a single apical cell, instead of a group of cells at the apex of the growing-point as happens in Flowering Plants, but this needs confirmation.

† The word "concrescent" is adopted by M. Van Tieghem, and seems to be coming into general use to express the condition formerly, but erroneously, called adnation, and by myself "inseparation," as denoting that kind of arrest of developmental change indicated by imperfect separation of two parts. The arrest of development in these cases is associated with rapidity and vigour of growth.

‡ It may be convenient to append in this place references to various works in which the mode of germination of different species is figured :—

Abies balsamea, pectinata, Pinsapo, Duchartre in Ann. Sc. Nat. sér. 3, t. x.

Foliation.

The leaves of Conifers assume varied appearances according to the age of the plant, their position and office. Thus, passing from the seedling state with its cotyledons already noticed, there may be primary leaves, secondary or true foliage-leaves, bud-scales or perulæ, bracts on the male and female inflorescences and anther-bearing leaves. These will be mentioned under their respective headings *.

Comparatively rarely all three portions of a perfect foliage-leaf are present at the same time. The blade, or lamina, is the part most often wanting; indeed it is questionable whether what is so called is not, in most cases, an expansion of the petiole, destitute of those modifications of venation and nerve-endings which characterize the lamina proper. In *Ginkgo*, for instance, the stalk expands into a leafy blade without any true midrib, the numerous veins being of nearly equal size, diverging from the top of the stalk-forking as in Ferns, but not connected one with another by side reticulations. The leaf-stalk, according to Fankhauser and Thomas, has the same anatomical structure as the secondary leaves of *Pinus* hereafter mentioned †.

In the Yew (*Taxus*), the Hemlock Spruces (*Tsuga*), and some others, the petiole is well marked and distinct from the lamina,

---

tab. 9 (1848). *Araucaria excelsa* (*Dombeya*), Lambert, Pinus, ed. major, t. 39; Forbes, Pinetum Woburnense. *Abies pectinata*, Willkomm, Forstl. Flora, p. 113. *Cedrus Libani*, L. C. Richard, Comm. Bot. de Conif. t. 14; Duchartre, *l. c.* *Dacrydium*, Nouv. Arch. Mus. iv. t. 3. *Ginkgo*, Le Maout and Decaisne, Gen. Syst. ed. Hooker, p. 747. *Larix europæa*, Duchartre, *l. c.*; L. C. Richard, *l. c.* t. 13. *Picea excelsa* (Link), Richard, *l. c.* t. 15; Willkomm, Forstl. Flora, p. 59; Fischer, Beiträge Monocot. und Polycot.; Sachs, Text-book, ed. Vines (1882), p. 508. *Pinus Cembra*, Fischer, Beiträge. *P. Elliottii*, Engelmann, Revision Pinus. *P. Pinea*, L. C. Richard, *l. c.* *P. Salzmanni*, Dunal in Mém. Acad. Sc. Montpellier, ii. p. 15, t. 2. *P. silvestris*, Willkomm, Forstl. Flora, p. 163. *P. pumilio*, Nees, Gen. Plant. Flor. Germ. *P. Strobus*, Henry in Act. Acad. Cæs. Leopold.-Carol. Nat. Cur. xix. p. 1 (1837), tab. xii. fig. 2. *Pinus australis*, *excelsa*, *Laricio*, *monspeliensis*, *Pinea*, *Pinaster*, Duchartre in Ann. Sc. Nat. *loc. cit.* *Taxus*, Nees, Gen. Plant. Flor. Germ. Various species of *Phyllocladus* and *Podocarpus* are figured in Kirk's 'Forest Flora of New Zealand.'

* See Zuccarini on the Morphology of the Coniferæ, section vi. p. 32. English Edition, Ray Society, 1846.

† Fankhauser, "Die Entwickelung des Stengels und des Blattes von *Ginkgo biloba*," Bot. Centralblatt, 1882, p. 229. Thomas in Pringsheim's 'Jahrbuch,' iv. p. 24.

but the vaginal portion of the stalk is absent unless the "pulvinus" be taken to represent it, a matter discussed under the heading of the minute anatomy: suffice it here to say that no such pulvinus occurs in these plants at the base of the perulæ, whose vaginal character will not be contested.

In the Red-Wood (*Sequoia sempervirens*), in *Cunninghamia*, in *Cephalotaxus*, *Torreya*, *Podocarpus*, and others, the perulæ are also broad-based, sheath-like, and have no pulvinus. In some of these plants, moreover, the base of the laminar or laminoid portion is not contracted into any petiole, but is concrescent with the stem (decurrent).

In many Conifers the leaf, in the adult state, is represented by the petiolar portions only; but in other cases, as for instance in the bracts of the cone of *Pseudotsuga Douglasii*, there are indications of vaginal and petiolar portions.

Arrangement of Leaves—Homotaxy and Heterotaxy.—The phyllotaxis of the leaves of Conifers is treated of in various text-books, so that a few peculiarities are all that demand attention in this place. Sometimes, as in *Sequoia gigantea*, *Araucaria imbricata*, *Abies Pinsapo*, the foliage is arranged in the same way throughout the entire tree (*Homotaxy*). More usually the arrangement varies in different parts of the tree. A change in the phyllotaxy is of course common in the case of the bud-scales, and also in the passage from the primordial to the adult foliage: thus in young plants of *Thuya gigantea* the leaves may be seen in two, three, or in four ranks. In other cases the change is more apparent than real, being brought about by concrescence in various degrees, the concrescence alternating more or less regularly with dialysis or freedom. Again, on the erect "leader-shoots" of various species of *Abies*, *Picea*, *Pseudotsuga*, *Tsuga*, *Taxus*, *Cephalotaxus*, &c., the leaves spread on all sides, while on the lateral branches, which spread more or less horizontally, they are arranged nearly in one horizontal plane*. In such cases the phyllotaxis is not altered, but the leaves are twisted more or less at the base so as to make them apparently distichous, while in reality they are still polystichous. Occasionally some of the side shoots will suddenly quit the horizontal direction and assume an erect attitude, as in *Picea Menziesii* and *P. ajanensis*. When this happens, the leaves spread on all

* *Abies Pinsapo* forms a constant exception to this rule, the leaves being invariably spreading in all directions.

sides as in the true leader-shoots. This change of direction is the original of some of the "fastigiate" varieties, as of the common Yew, where the branches, instead of spreading more or

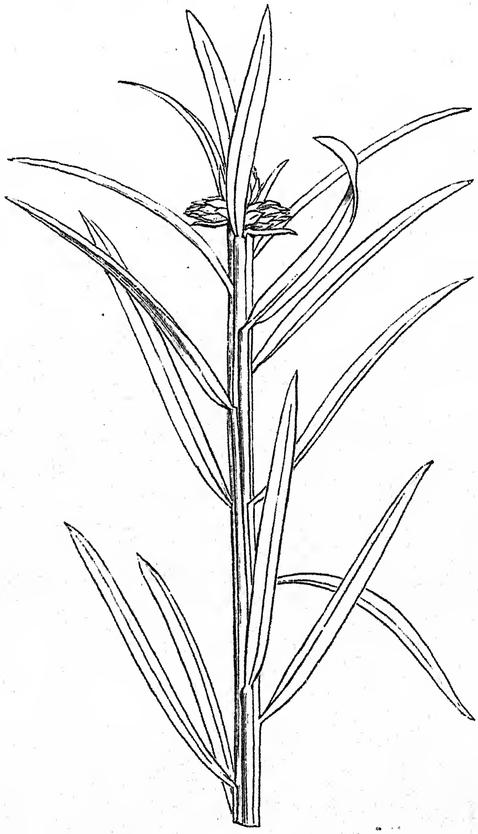


Fig. 4.—*Cephalotaxus Fortunei*, leader-shoot with scattered many-ranked leaves.

less horizontally, assume an erect position, and the leaves are then given off on all sides, not being twisted at the base (see figs. 4, 5).

A fastigiate branch may thus originate as a sport or bud-variation, as is seen in *Taxus*, *Cephalotaxus*, and other species.

A remarkable correlation may frequently be observed in such cases between the size and the direction of the leaves. Thus in the variety *brevifolia* of *Pseudotsuga Douglasii* the stature of the plant is relatively dwarf, and the leaves not only spread on all sides but are much smaller than in the normal state, where they spread in one horizontal plane only. In other cases the leaves

are longer than usual. M. André describes (in the 'Illustration Horticole' for 1870, p. 106) a variety of the common Silver Fir, *Abies pectinata*, in which, in conjunction with a regularly pyramidal outline of the whole tree, the leaves were not pseudo-distichous but spreading on all sides. Similar phenomena may

Fig. 5.—*Cephalotaxus pedunculata*, var. *fastigiata*, showing the terminal shoot with scattered pluriseriate leaves, and a lateral shoot with pseudo-distichous leaves.

be seen in the dwarf varieties of the common Spruce, *Picea excelsa* var. *pygmæa*, &c. In *Picea excelsa* var. *monstrosa* and var. *viminalis* a very curious condition occurs in which the leaves are

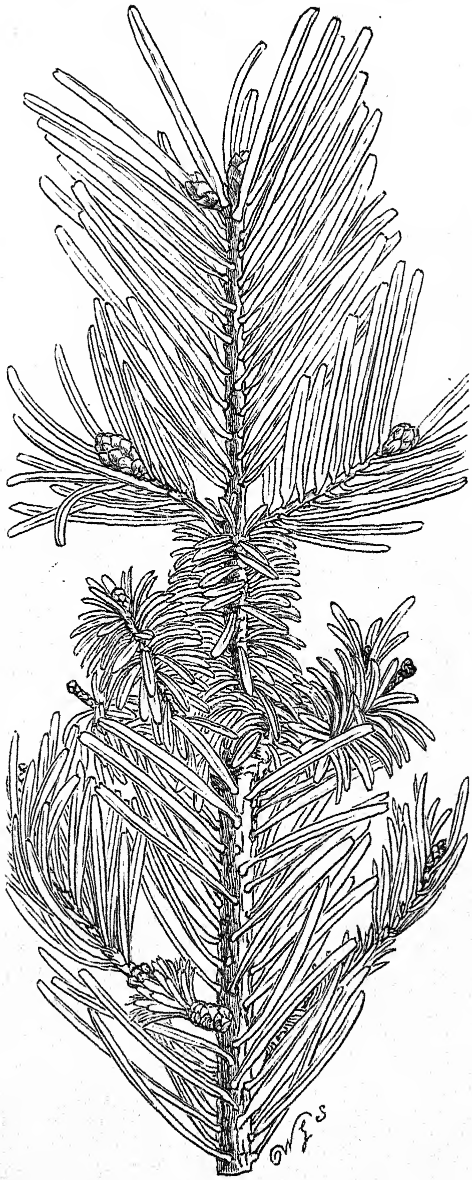


Fig. 6.—*Abies Nordmanniana,* showing varying dispositions of the leaves in consequence of alternating rapidity and slowness of growth.

homotaxic, but much longer than ordinary, and owing to the rarity with which lateral buds are formed the main branches are elongated and unbranched, suggestive of a resemblance to snakes. It is interesting to compare these forms with the arrangement in young plants of *Araucaria imbricata*. These curious firs will be spoken of again under the head of "ramification."

Changes in the appearance and disposition of the leaves also occur as a result of alternations of growth and of arrest of growth in various degrees. Thus, when growth first begins in spring, it proceeds rapidly, and then may come a period of arrest and contracted growth. Thus we may have, at different parts of the same branch, long leaves arranged in a pseudo-distichous manner, and others much shorter and spreading on all sides, as shown in the accompanying illustration from *Abies Nordmanniana* (fig. 6).

The genus *Podocarpus* presents marked illustrations of heteromorphy and of heterotaxy in the foliage. The leaves on some of the quickly growing shoots are distichous, arranged in one flat, horizontal plane, the individual leaves being broadly linear and somewhat falcate, while on the older or less quickly growing shoots the leaves are polystichous, short, subulate, and appressed to the stem.

Another instance of variation in the arrangement of leaves is often seen in *Abies Nordmanniana*, *A. Pichta*, *A. amabilis*, as also in *Tsuga canadensis*, &c. The leaves on the lateral and more or less horizontally spreading branches, though polystichous, in reality arrange themselves in three rows, one on either side of the branch (in which case the leaves are nearly at a right angle to the branch), and one in the median plane of the upper surface (in which case the leaves are appressed along the branch parallel to its main axis). The median leaves are usually smaller than the lateral ones. This arrangement may be compared to that in the species of *Selaginella*, or to that in *Lycopodium spectabile*, *L. volubile*, &c., where the lateral leaves are relatively large and decurrent, while the median leaves (dorsal as well as ventral in these instances) are relatively small, free at the base and caducous. In *Abies grandis* the uppermost row of leaves is not arranged parallel to the axis, as in the instances just referred to, but at right angles in the ordinary way, the obstruction caused by the overlapping leaves being minimized by the smaller size of the upper leaves, and by the power which the leaves have of raising or depressing themselves according to circumstances.

The leaves on the erect shoots being crowded and overlapping one another more completely than elsewhere, are less favourably situate as regards access of light than those on the side shoots, in which, owing to the arrangements before mentioned, the internecine competition is less severe, hence one reason for the speedier fall of the leaves from the erect shoots and the more crowded parts of the tree, and the comparatively naked interspaces between the whorls of branches.

The disposition of the leaves of these plants indeed seems to be arranged to secure an equitable share of light and as equal exposure as possible to the whole mass of foliage, thus reducing competition among individual leaves to the greatest possible extent. In some cases, the arrangement is such as to secure the exposure of the stomatiferous surface to the light and heat, as in cases where the leaves are appressed against the stem in such a way as to leave the stomate-bearing surface free *.

The *movements in the leaves* of many Conifers during the season of active vegetation particularly, and which take place under the influence of sunlight, have presumably a similar object. In *Picea ajanensis* the stomata are on the upper surface of the leaf, and consequently appressed to the lateral branches, while the green dorsal surface is exposed to the light. The uplifting of the leaves, however, permits the stomatic surface to be exposed upon occasion †. Mr. Moggridge alludes to this subject in a note on the movements of the leaves of *Pinus halepensis* ('Journal of Botany,' Feb. 1, 1867). The leaves of this tree in warm sunny weather are fully separated, but if the sky become overcast they close partially; the sirocco produces a similar but more marked effect, but in rain the leaves collapse, giving the tree a most melancholy aspect. A similar change is observable in most Pines in summer and winter respectively, at which latter season they are nearly parallel, not divergent. Probably the state of things in some cotyledons, as before mentioned, and in the primordial

* E. Mer, "De l'influence de l'ombre et de la lumière sur la structure, l'orientation et la végétation des aiguilles d'*Abies excelsa*," in Bull. Soc. Bot. France, t. xxii. p. 199, t. xxiv. p. 109, t. xxvi. p. 15, t. xxvii. p. 23, and t. xxx. (1883) p. 40; and Comptes Rendus, April 16, 1883.

† Chatin, "Sur les mouvements périodiques des feuilles d'*Abies Nordmanniana*," in Bull. Soc. Bot. France, xxiii. p. 103 (1876). Masters, "On the Relation between Morphology and Physiology in the Leaves of certain Conifers," in Journ. Linn. Soc., Bot. xvii. (1879), 547, &c.

leaves of *Juniperus*, *Thuya*, &c., in which the stomata are more abundant and more freely exposed than in ordinary foliage-leaves, may similarly be connected with the need for rapid evaporation through the stomata. In any case the arrangement, the torsion, and the movements of leaves seem in some cases, and at some periods, to promote the exposure of the assimilating or green side of the leaf, and in other cases (or in the same cases at different periods) to facilitate the exposure to light and heat of the stomate-bearing surface. In all probability these differences are directly connected with the assimilating process on the one hand, and with the respiratory and exhaling processes on the other.

Anatomy of the Leaf.—The complete discussion of anatomical details lies without the scope of the present communication. Information concerning them may be obtained from the ordinary text-books and, in particular, from the memoirs cited in the bibliographical list appended to this communication.

Certain peculiarities of structure have, however, been proposed as adjuncts to the discrimination and classification of the species, and on that account demand some notice here. The epidermis covering the adult leaves is represented in the cotyledons of many species by a soft papular layer apparently destitute of cuticle. In both cases the epiderm is perforated with stomata whose distribution and number afford useful aids in classification, while their physiological significance is obviously a matter of importance. In most cases (in all, so far as my own examination enables me to say) the cotyledons have the stomata arranged on their uppermost or innermost surface (see p. 239). In the adult leaves the stomata are variously disposed on one or both surfaces, as is illustrated by the following list taken principally from Bertrand * :—

Stomata on lower surface chiefly :—*Taxus*, *Torreya*, *Cephalotaxus*, *Ginkgo*, *Saxe-Gothea*, *Podocarpus*, *Prumnopitys*, *Cunninghamia*, *Agathis*, *Cedrus Libani*, *C. Deodara*, *Picea sitchensis*, *jezoensis*, *Tsuga canadensis*, *Brunoniana*, and *Sieboldi*, *Pseudotsuga Douglasii*, *Abies firma*, *cephalonica*, *pectinata*, *Pindrow*, *cilicica*, *bifida*, *bracteata*, *Veitchii*, *sibirica*, *homolepis*, &c., &c.

Stomata on upper surface chiefly :—*Juniperus*, *Athrotaxis Gunniana*!, *Libocedrus tetragona*!, *Cedrus atlantica*, *Picea ajanensis*, *Tsuga Hookeriana*, *Abies nobilis*, *Davidiana*, *grandis*, *Reginæ-*

* See also Hildebrand, "Bau d. Spaltöffnungen der Coniferen," Bot. Zeit. 1860, p. 17.

Amaliæ, numidica, Pinsapo?, *Fraseri, balsamea, Larix Lyallii, americana*, &c., &c.

Stomata on both surfaces:—*Fitzroya, Cryptomeria, Taxodium, Sequoia, Athrotaxis cupressoides, Dacrydium*, some species of *Podocarpus*.

Araucaria Cunninghami (four bands), *excelsa* (four bands of 5 rows each), *Balansæ* (4 bands of 8 rows), *Cookii* (2 bands of 50 rows), *Rulei* (3 bands), *montana* (3 bands), *Muelleri* (3 bands), *brasiliensis* (65 rows on each side), *imbricata* (70 rows on each side), *Bidwillii* (90 rows on each side)" (*Bertrand*). *Picea nigra, alba, Khutrow, polita*.

Stomata on two surfaces, but absent on the lower surface:—*Frenela, Widdingtonia, Libocedrus, Thuyopsis, Cupressus, Juniperus, Athrotaxis laxifolia* and *selaginoides, Pinus Strobus, excelsa*, &c., &c.

In some cases the stomata are disposed in longitudinal bands, as in species of *Pinus, Abies*, &c., &c., or they may be irregularly dispersed, or they may occur in patches in certain privileged localities, as in *Juniperus*, where they occur in a triangular patch on the upper surface at the base of the spreading leaves, e. g. in *Juniperus drupacea*.

The position of the stomata in Conifers is very generally indicated by the existence of a glaucous bloom *, but this is not always confined to the immediate vicinity of the stomata, but may, as in *Picea pungens* var. *glauca* and others, be distributed over the whole surface of the leaf.

The Hypoderm.—Within or beneath the epiderm is usually to

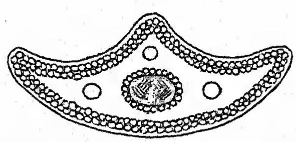


Fig. 7.—*Pinus patula*. Plan of transverse section of leaf, showing epiderm, two layers of hypoderm, three resin-canals in the centre of the leaf, endoderm, and pericycle.

be found a layer, or sometimes more, of long, thick-walled strengthening-cells, either forming an unbroken sheet or perfo-

* Francis Darwin, "On the Relation between the Bloom on Leaves and the Distribution of Stomata," Journ. Linn. Soc., Bot. vol. xxii. (1886) p. 99.

rated by the stomata, thickened by additional layers in certain spots, as at the angles of the leaves, over the midrib, round the resin-canals, and sometimes broken up into thick detached islets, a remarkable instance of which is afforded in *Pinus Coulteri*, the leaves of which have triangular wedge-shaped masses of hypoderm projecting into the mesophyll. Stahl says that in *Abies pectinata* the hypoderm-cells are most abundant on the side of the leaf exposed to the sun, least so on the shady side.

Messrs. Coulter and Rose point out the presence in certain of the North-American species of *Pinus* of a layer of relatively thin-walled cells between the epidermis and the strengthening-cells proper. This layer is indicated by them in the following species:—*P. monticola, albicaulis, flexilis, reflexa, Strobus, Ayacuite, resinosa, contorta, muricata, Engelmanni, Coulteri, ponderosa, tuberculata, arizonica*, and *Montezumæ*.

The Mesophyll.—Within the hypoderm, and forming the chief substance of the leaf, is the mesophyll, generally wholly cellular, the constituent cells containing chlorophyll being uniform or nearly so, as in *Picea*, while in others there is a distinction into palisade-cells, on one side (*Abies*), or on both surfaces (*Araucaria imbricata*), but in any case most conspicuously on the side most exposed to the light, and branching cells with lacunæ between them (*Abies*). In some species the cells appear to radiate from the central bundle (*Picea*, spp.). In *Pinus* they are remarkable for the involutions of their walls, causing flat projections into the interior of their cavities. In other cases a series of colourless cells spread laterally from the central bundle in the midst of the chlorophyll-containing cells of the mesophyll and constituting the transfusion-tissue. This may be seen in *Keteleeria Fortunei*!, *Pseudo-larix Kæmpferi*!, some species of *Podocarpus*, e. g. *P. chilensis*! Very large, branching, thick-walled cells like those of *Welwitschia* are found in *Araucaria imbricata* and other species of the order.

The Resin-canals.—Traversing the mesophyll are the resin-canals, which demand notice from the constancy of their arrangement *. Their presence is, to some extent, variable; but when they do occur it is usually in definite numbers and in certain

* In the stem they occur in the middle of the cortex, generally as a single row, but in some species of *Pinus* where the cortex is very thick there are several rows. They also occur in some cases in the secondary wood, whilst in *Ginkgo* they are to be found in the pith.

well-defined situations. Thus in all the species of *Tsuga* there is one central resin-canal immediately beneath the central vascular bundle, and a similar arrangement prevails in *Torreya*, *Cephalotaxus*, *Podocarpus*, *Saxe-Gothea*, *Sciadopitys*, *Fitzroya*, *Cryptomeria*, *Sequoia*, *Taxodium*, *Juniperus*, &c.

In the species of *Larix* there are two canals, one at each angle of the leaf beneath the epiderm. A very common arrangement is that in which the canals are placed within the epiderm on the lower surface on either side of the midrib, or there may be several canals arranged all round the leaf at intervals beneath the epidermis, as, for instance, in *Pinus Strobus*, *monophylla*, *Cembra*, and in some species of *Araucaria* and *Altingia*.

In other instances, as in *Pinus Pinaster*, *mitis*, *inops*, *Tæda*, *Lambertiana*, *Araucaria imbricata*, *Abies Veitchii*, &c., &c., the resin-canals are in the centre of the mesophyll, while in *Pinus pseudostrobus* &c. they are almost or quite in contact with the endoderm. In three-sided leaves of some species of *Pinus*, if there be but one canal, it is placed under the epidermis in the centre of one side, if three then there is one in each of the three angles of the leaf. Engelmann accordingly spoke of the ducts as peripheral, or subepidermal, parenchymatous, and internal, and grouped the species of *Pinus* in large measure according to the position of the ducts.

The arrangement of the canals is sometimes different in the primordial and in the secondary leaves respectively, and in *Pinus Lambertiana* the resin-canals are sometimes subepidermal, sometimes parenchymatous.

The canals are sometimes separated from the mesophyll by a well-marked ring of thick-walled cells, often continuous with the hypodermal cells, but occurring sometimes around those ducts which are placed in the centre of the mesophyll; thus the resin-canals of *Pinus* are:—

1. Entirely surrounded by "strengthening-cells," e. g. *Pinus silvestris*, *Laricio*, *Pinea*, *serotina*, *nigricans*, *Peuke*, *deflexa*, *ponderosa*.

2. Encompassed by thick-walled cells with thin-walled cells intermingled, e. g. *Pinus densiflora*, *Coulteri*, *Torreyana*.

3. Begirt by thin-walled cells only, e. g. *Pinus maritima*, *hudsonica*, *Strobus*, *pyrenaica*, *insignis*, *Jeffreyi*, *longifolia*, *canariensis*, *excelsa*, *argentea*, *monticola* *.

* See Möbius, in Jahrb. f. wissensch. Botanik, t. xvii. p. 263 (1885).

The Endoderm.—The mesophyll is limited on the inner side by the endoderm or bundle-sheath, consisting of a single row of oval cells, sometimes more or less thickened by collenchymatous deposit at the points of contact. The endoderm is usually very well marked in species of *Pinus*, *Abies*, and *Picea*, while in *Phyllocladus*, *Podocarpus*, *Dammara*, *Fitzroya*, *Juniperus*, and *Sciadopitys* it is generally ill-defined.

The Pericycle.—The endoderm immediately encircles the pericycle, which is composed of parenchymatous tissue of varying amount, destitute of chlorophyll, but often containing starch [probably always at some stage of their existence]. These cells are usually thin-walled and small, but are often intermixed with a small number of relatively very large, thick-walled prosenchymatous cells. In those cases where the fibro-vascular bundle remains unbranched the pericycle is cylindrical, circular in outline as seen in section, e. g. *Pinus Lambertiana*, *Pseudolarix Kæmpferi*, *Picea* spp., &c., &c.; but if the bundle is double, *i. e.* divided, then the pericycle is transversely oval or reniform in section.

The Fibro-vascular Bundle.—The centre of the pericycle is occupied by the fibro-vascular bundle. In most cases there is but one such bundle (constituting the midrib), but in other cases, as in *Araucaria*, there are several such bundles traversing the leaf, each with its own pericycle and forming several ribs.

The central bundle is usually undivided throughout its course, but sometimes it bifurcates, and then on a transverse section an appearance is presented as of two bundles, often separated at the dorsal side by a wedge-shaped mass of thick-walled cells; so that the two divisions of the bundle, instead of being in one transverse plane (——), are now inclined (⁄ ⍀) one to the other. In *Pinus rigida* and some others the masses of xylem, instead of pointing upwards and inwards, point outwards (⍀ ⁄), diverging from the base.

The central bundle consists of phloem elements on the outer or dorsal side and xylem on the inner side. In *Sciadopitys* the relative position of these elements is reversed.

The phloem-cells are more thin-walled than the xylem-cells, the mass of which latter presents in section a wedge-shaped outline, the base towards the phloem, the truncated apex towards the centre and upper side of the leaf. The xylem-cells are usually packed in regular series, so that on section the rows seem to

radiate towards the centre, and sometimes the rows are separated by medullary rays. The phloem-cells, on the other hand, are much less regularly disposed. The total quantity of xylem and phloem in relation to the pericycle and the relative amount of xylem and phloem in the same bundle vary very considerably in different species.

A single unbranched bundle within one pericycle is met with in *Fitzroya*, *Juniperus*, *Cryptomeria*, *Sequoia*, *Athrotaxis*, *Cephalotaxus*, *Taxus*, *Torreya*, *Ginkgo*, *Phyllocladus*, *Saxe-Gothea*, *Podocarpus*, *Cunninghamia*, *Araucaria*, *Sciadopitys*, some species of *Pinus*, as in *P. albicaulis*, *flexilis*, *reflexa*, *Strobus*, *Ayacuite*, *monticola*, *Lambertiana*, *monophylla*, *edulis*, *cembroides*, *latisquama*, *Parryana*, *Balfouriana*, *aristata*, *Cembra*, in *Abies nobilis*, *magnifica*, *Keteleeria Fortunei*, *Pseudotsuga Douglasii*, in species of *Cedrus*, *Picea*, *Larix*, *Tsuga*, &c.

A branched bundle occurs in the cladodes of *Sciadopitys*, in *Abies amabilis*, *grandis*, *Lowiana*, *concolor*, *lasiocarpa*, *Fraseri*, *balsamea*, *sibirica*, *Veitchii*, *firma*, including *bifida*, *homolepis*, *Pindrow*, *Webbiana*, *pectinata*, *Nordmanniana*, *cilicica*, *cephalonica*, *Pinsapo*, *numidica* &c., and in the following species of *Pinus*:—*bracteata*, *religiosa*, *contorta*, *muricata*, *Engelmanni*, *Coulteri*, *ponderosa*, *Montezumæ*, *Torreyana*, *Jeffreyi*, *Pinaster*, *Tæda*, *Sabiniana*, *serotina*, *rigida*, *insignis*, *pungens*, *tuberculata*, *inops*, *clausa*, *mitis*, *glabra*, *Banksiana*, *palustris*, *cubensis*, *Laricio*, and *silvestris*.

In considering these characters as available for systematic purposes it may here be remarked that the arrangement of the stomata usually affords a good (that is a relatively little variable) character, that the presence and thickness of the hypoderm are less reliable, being dependent on climatic influences and exposure, that the characters afforded by the mesophyll are of great importance, though not worked out in all the species, that the position of the resin-canals is of more consequence than their number, while the undivided or branched condition of the vascular bundle, as pointed out by Messrs. Coulter and Rose, is a character of high value. Minute structural characters are, however, no more absolute than other diagnostic points, although serviceable "for use in the absence of other characters" *.

* In addition to the authors incidentally mentioned and to the general treatises of Strasburger, Sachs, De Bary, Van Tieghem, &c., reference may here

Homomorphy and Heteromorphy.

The adult leaves, or those produced on the vegetative system of the plant, in succession to the cotyledons, may be of the same pattern or they may vary in different stages of the plant's growth, or on different parts of its branches. In that form of *Thuya* known in gardens as *T. Bodmeri*, and in that known as *Retino-*

---

suitably be made to others who have studied the anatomy of the leaves from various points of view :—

Thomas in Pringsheim's Jahrb. iv. p. 43 (1865).

Frank, "Ueber den Einfluss des Lichtes," in Pringsheim's Jahrbuch, ix p. 147.

Bertrand, Anat. Comp. in Ann. Sc. Nat. sér. 5, vol. xx. p. 5, c. tabb. 12 (1874).

MacNab in Proc. Irish Acad. ii. (1877).

Engelmann, Revision of the *Pinus* (1880), p. 165.

Coulter and Rose in Botanical Gazette, vol. xi. (1886), p. 256.

Stahl, "Ueber den Einfluss d. Beleuchtung," in Sitzungsb. Jenaisch. Gesellsch. f. Med. und Naturwiss. (1882).

Karlston, "Das Transfusionsgewebe bei den Coniferen," Bot. Centralblatt, 1879, p. 730.

Dufour, "Influence de la lumière sur les feuilles," in Ann. Sc. Nat. (1887), p. 314.

Daguillon, "Obs. sur la structure des feuilles de quelques Conifères," in Bull. Soc. Bot. France (1888), t. xxxv. p. 57.—*Picea excelsa, Abies bracteata, Taxus baccata.* The author describes the varying structure of the leaves on the leading and on the lateral shoots respectively. *Idem*, "Recherches Morphol. sur les feuilles des Conifères," in Revue Gén. Bot. t. ii. April 15, 1890, p. 154.

P. Klemm, "Ueber den Bau der beblätterten Zweige der Cupressineen," in Pringsheim's Jahrbuch, xvii. (1886), p. 498, t. xxxvii.

A. Mahlert, "Beiträge zur Kenntniss der Anatomie der Laubblätter der Coniferen," in Botanisch. Centralblatt (1885), p. 54 *et seq.*

E. Henning, Analysis in Journ. R. Microscop. Society (February 1888), p. 78.

De Bary, Comp. Anat of the Vegetative Organs (ed. Bower and Scott, 1884), pp. 300, 380.

R. v. Wettstein, "Ueber die Verwerthung anatom. Merkmale zur Erkennung hybrider Pflanzen," Sitz. d. k. Akad. d. Wissensch., Band xcvi. (1887), cum ic.

G. Kraus, "Mikroscop. Untersuch. über den Bau lebender und vorweltlicher Nadelhölzer," in Würzburger natur. Zeitsch. v. (1864) tab. 5. (Not seen.)

Geyler, "Ueber das Gefässbundel Verlauf in d. Laublattregionen der Coniferen," in Pringsheim's Jahrb. vi. (1867).

G. Sanio, "Anat. d. gemeiner Kiefer," in Pringsheim's Jahrb. ix. (1873), p. 87.

Goebel, "Ueber d. Jugendzustande der Pflanzen," in Flora, 1889; also "Beitrag zur Morphol. u. Physiol. d. Blatter," in Bot. Zeitung, xxx. 1880.

Meyer, Die Harzgänge in Blatt d. Abiet. Königsberg (1883). (Not seen.)

Noack, "Der Einfluss des Climas auf d. Cuticularisation und Verholzung der Nadeln," in Pringsheim's Jahrb. wissen. Bot. xviii. 1888. (Not seen.)

Coulter, "Histology of the Leaf in *Taxodium*," in Botanical Gazette, March 1889, p. 76.

spora tetragona aurea (a form of *Thuya obtusa*), the median and the lateral leaves are equally conduplicate, so that the branch system is four-cornered instead of flattened as it usually is in the genus *Thuya*, and which finds a parallel in the case of *Lycopodium tetragonum*. In other forms of *Thuya*, such as *T. plicata* and *T. Wareana*, hort., the lateral leaves (always flattened) are so inordinately so that they become almost like the median ones in appearance. In *Sequoia gigantea*, *Taxodium distichum*, and *Fitzroya patagonica* the leaves are all of one pattern throughout. On the other hand, in the so-called genus *Retinospora*, comprising species belonging to the genera *Thuya*, *Chamæcyparis*, and *Juniperus*, the leaves may occur in three or more different forms. Individual plants propagated by grafting or cuttings may present one type of foliage only, and thus it is that different species and even a separate genus have been created on what are only forms peculiar to certain stadia or stages of growth. Two or more forms have been observed on the same plant, or the plant has been watched from the seedling state and the pleiomorphism thus detected.

Engelmann * mentions seven descriptions of leaves in *Pinus* :—1, cotyledons; 2, primary leaves; 3, bud-scales, which he calls bracts; 4, the true or secondary leaves; 5, the scales constituting the sheath of the fascicles of leaves; 6, the bracts of the male inflorescence; and 7, the bracts outside the carpellary scales. These seven may, however, all be reduced to two categories, leaves and leaf-scales.

There is a frequent correlation between the form of the branch and that of the leaves; thus, in *Libocedrus tetragona* the branches are subterete and the leaves uniform in shape, spreading and regularly arranged in four rows. Similar regularity of form and disposition occurs in *Taxodium distichum* var. *imbricaria*, in *Thuya filifera*, hort., *Abies Pinsapo*, &c. On the other hand, where the branches are flattened, either from side to side or in the median plane, the leaves are generally appressed and unequal in size, the median ones being smaller and flatter than the lateral ones, which are often conduplicate. In *Libocedrus Doniana* the sterile branches are flattened and bear appressed dimorphic leaves; the fertile branches bear spreading leaves only, and these pass by imperceptible gradations into the scales of the

* Engelmann, Revision of the Genus *Pinus*, p. 163.

cone. Illustrations of these facts, as well as numerous transitional stages, may be seen in various species of the genus *Thuya*, in *Libocedrus decurrens* and *L. macrolepis*. These homomorphic leaves may be compared with the primordial leaves produced out of season, as will be more fully alluded to in the following paragraph. They may also be compared with the similarly uniform leaves of the species of *Lycopodium*.

Primordial or Protomorphic Leaves.—In many cases the leaves which immediately follow the cotyledons differ in form, attachment, arrangement, and, to some extent, even in structure from those which characterize the adult state of the trunk or branches.

In *Callitris*, *Frenela*, *Libocedrus*, *Thuya gigantea*, *Cupressus glauca*, *C. sempervirens*, *C. nutkaensis*, *Lawsoni*, *funebris*, *macrocarpa*, *Cryptomeria japonica*, *Sequoia gigantea*, *Phyllocladus*, *Araucaria excelsa* (see fig. 3, p. 234), some species of *Abies*, as in *A. Apollinis* and *grandis*, in *Pseudotsuga Douglasii*, *Picea excelsa*, *Menziesii*, *orientalis*, *Larix Griffithii*, *Cedrus atlantica*, the primordial leaves are in many rows, more or less linear, and entirely free or but slightly concrescent at the base, but never appressed. In the *Piceas* the pulvini are not observable at the base of the lowermost leaves.

The stomata are usually on the lower surface of these primordial leaves, but sometimes on both, as in many species of *Pinus**. In *Cedrus* and *Larix* the primordial leaves are linear or awl-shaped, mucronate, with longitudinal rows of stomata on all sides, as in *Picea*.

In *Taxus baccata*, *Picea Menziesii*, *Tsuga Mertensiana*, *Sequoia gigantea*, *Abies Pinsapo*, &c. the primordial leaves do not greatly differ in appearance from the adult leaves.

In some species of *Araucaria*, as previously mentioned, the

* Daguillon, in a paper "Sur le polymorphisme foliaire des Abietinée," Comptes Rendus, 1889, p. 108, Jan. 14, published since this paper was presented to the Society in November 1888, says the stomata are always to be found on both sides of the primordial leaves, even in *P. Strobus*, where in the adult condition they occur on the upper surface only. In *Abies*, in which genus the adult leaves are in one plane, the same author describes the primordial leaves as forming a whorl, whereas in *Picea* they are alternate, as are the adult leavés, as also in *Cedrus* and *Larix*, where the adult leaves are tufted. The absence of hypoderm and the generally diminished or arrested differentiation of structure as compared with the permanent leaves are also alluded to by M. Daguillon. See also Beissner, "Ueber Jugendformen v. Pflanzen speciell von Coniferen," in Berichte d. deutsch. Bot. Gesellsch. vi. 1888, pl. xxxiii.

primordial leaves are different in character from the adult ones while in other species of the same genus, as in *A. imbricata* and *A. brasiliensis*, the form of the primordial leaves is practically the same as that of the adult plant (see *antè*, fig. 3, p. 234).

In *Ginkgo* the primordial leaves are tristichous, alternate, remote, and pass gradually into those of the adult stage (see *antè*, fig. 1, p. 233).

In *Sciadopitys* the primordial leaves are alternate, spreading, long, linear-oblong, and in subsequent stages become reduced to ovate convex scales differing only from perulæ in being rather more leafy in character.

In *Pinus* the primordial leaves * were recognized by Linnæus in *Pinus Pinea* (see fig. 8). They are, so far as known in various species, flat, linear-lanceolate, generally serrulate at the edge (almost exactly as in the leaves of *Lycopodium serrulatum*), and arranged as in *Sciadopitys*.

In some species, as in *P. rigida*, *P. silvestris*, as also in the Douglas fir and doubtless in many others, as a result of injury to the main shoot, the axis commences to branch at the very base just above the cotyledons, and these primary branches produce only primordial leaves.

When a young shoot branches at the base, so that there are belonging to the same generation a central shoot and a whorl of lateral offsets from it, then it often happens, as in *Pinus insignis*, that in the quicker-growing and more vigorous central shoot the fasciculate leaves are at once produced, while the side-shoots of weaker growth bear primordial leaves only, without buds or fascicles in their axils.

Usually it happens that the primordial leaves gradually pass into the position of perula-like scales, or, as they have been called, *squamæ fulcrantes*, when they have in their axils tufts or fascicles of leaves. Occasionally these leaf-scales, by an excess of development, develop into true linear leaves arranged spirally, and each separated from its fellow by an internode of considerable length. Leaves of this character occur frequently on the lower part of the shoots of the year, as in *Pinus Sabiniana*, *Pinea*, *silvestris* (sometimes), and other species. In some cases even they are produced from old woody branches or even from the trunk, as in *Pinus edulis*, *Parryana*, *rigida*, *khasyana*.

* See Linnæus, Syst. ed. Gmelin, 1791, p. 1072; Tristan in Ann. du Muséum (Mém. sur le genre *Pinus*, p. 242); Engelmann, Trans. Acad. St. Louis (1880), vol. iv. tab. i., *Pinus Elliotti*.

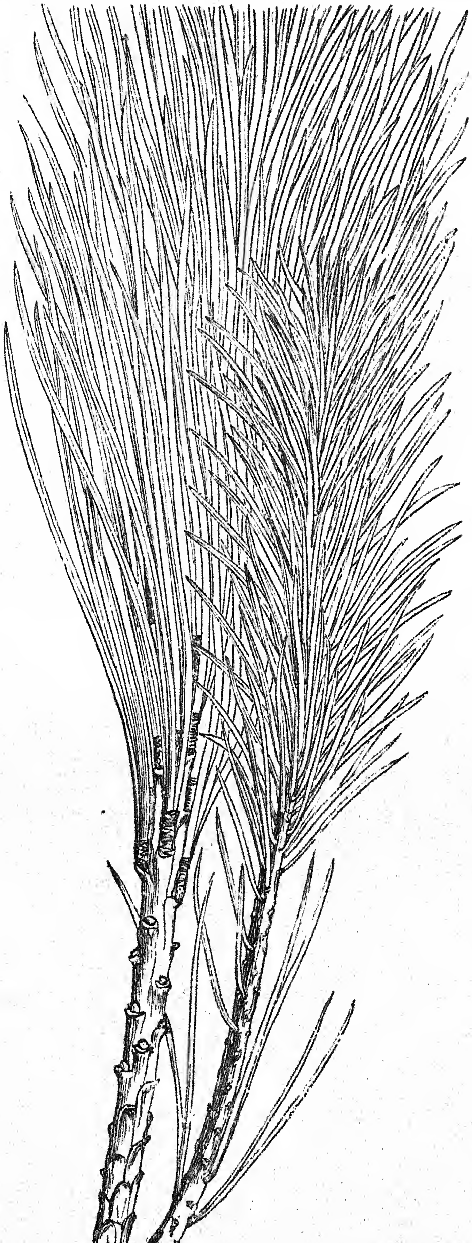


Fig. 8.—*Pinus Pinea*, showing fascicled and scattered leaves.

Mirbel, speaking of the buds of *Pinus,* says:—" Ces bourgeons naissent dans l'aiselle des véritables feuilles, lesquelles sont sèches minces et fugaces dans les arbres qui ont atteint leur troisième ou quatrième année, mais sont vertes et herbacées dans ceux qui n'ont qu'un ou deux ans . . . les véritables feuilles . . . dans l'aiselle desquelles naissent les bourgeons . . . . acquièrent quelquefois sur les branches des vieux pins la forme et la consistance qu'elles offrent toujours sur les jeunes tiges; et c'est ainsi que les espèces du genre reprennent, comme par accident, les caractères qui semblent être les plus conformes à leur organisation primitive."

Richard also, in his "Mémoire sur les Conifères," says, "Les feuilles sont d'abord solitaires dans les Pins, pendant la première et la seconde année après leur germination," alluding, of course, to the primordial leaves *.

A similar formation of leaves homologous with the primordial leaves is seen, in some cases, on the branches or stalks immediately supporting the cones, as in *Pinus excelsa* &c.

The structure of the primordial leaves of *Pinus*, although essentially the same as that of the secondary leaves to be hereafter noted, yet presents some interesting features. The epidermis is papular and there is no hypoderm. The mesophyll is made up of spheroid cells, the walls of which are not infolded like those of the secondary leaves. The endoderm and enclosed pericycle are not well marked off, but the central fibro-vascular bundle is perfectly conformed and has the same essential structure as in the secondary leaves, with this important exception that, whereas in the secondary leaves the bundle generally divides into two, in the primordial leaves it remains undivided. The resin-canals, when present, are sometimes placed in a different position to that which they occupy in the secondary leaves; thus, in *Pinus Lambertiana* the resin-canals of the primordial leaves are close to the lower epidermis, while in the more permanent leaves they are in the centre of the mesophyll. The mechanical structure as above indicated is less highly developed than in the secondary leaves, which have to bear a greater strain.

* Mirbel, "Observ. sur la famille des Végétaux, Conifères," in Ann. du Muséum d'Hist. Nat. xv. 1810, p. 475.

Henry, "Beitr. z. Kenntniss d. Laubknospen," in Act. Acad. Leopold.-Cur. xix. P. i. p. 93, tab. xii. fig. 6 (1837).

M. Kronfeld, "Ueber Polyphyllie b. *Pinus Mughus* u. *silvestris*," in Verhandl. d. k. k. zool.-bot. Gesellsch. in Wien, 38, Bd. iv. 1888. (Not seen.)

Sometimes leaves of a similar character to the true primordial leaves occur on the adult plant, either universally, as in some of the Retinosporas before alluded to, or in association with leaves of the ordinary appearance, when the foliage becomes in consequence dimorphic. Thus, in *Juniperus sinensis*, *Cupressus macrocarpa*, *Retinospora leptoclada* (hort.), &c., it is very common to find on some shoots small appressed leaves and others spreading, relatively long and awl-shaped *. The two forms of leaves sometimes occur on the same branchlet, and the degree of concrescence is relatively small. A similar thing occurs in some species of *Frenela* †. In these cases the long awl-shaped leaves are of the same form and have the general appearance of the primordial or protomorphic leaves, as is clearly seen in seedling plants of *Juniperus phœnicea*, in which in the adult state the four-cornered branches are covered with densely crowded, appressed, 4-ranked leaves, while the seedling plant has linear spreading leaves.

In some species of *Dacrydium*, as in *D. elatum*, *Colensoi*, and *Kirkii*, there are remarkable differences between the young leaves, which are spreading and more or less elongate, and the mature foliage, which is short and appressed ‡. Kirk, in his monograph of *Dacrydium* §, makes two divisions of this genus. In the one, the young leaves are terete and spreading, and pass by gradual transitions into the mature imbricating state, while in the other the young leaves are linear, flat, and pass abruptly into those characteristic of the adult condition.

The genus *Podocarpus* presents illustrations of similar diversity; thus, in *P. cupressina* and *P. dacrydioides*, &c. ‖, the leaves on the younger branches are spreading, broadly linear and falcate, while in the more mature state they are polystichous, small and appressed.

* It is interesting to notice that Dioscorides, lib. 1, cap. 88, recognized the two forms:—"Sabina duorum generum est, una foliis cupresso similis spinis horridior graviter olens acris et fervens arbor est coactæ brevitatis quæ sese magis in latitudinem fundit . . . . . . altera tamarisci folio similis est." See also Chabræus, Stirpium Icon. p. 72, where both forms are figured.

† See Pasquale, *loc. ante cit.*, and Brongniart et Gris in Bull. Soc. Bot. France, xvi. p. 327.

‡ Hooker, Icones Plantarum, tab. 1219.

§ Kirk in Transact. N.-Zealand Institute, xi. (1877) p. 383; also in his 'Forest Flora of New Zealand' (1889), with many illustrations.

‖ Brown and Bennett, Plant. Javæ, t. 10.

Araucaria Cookii presents an illustration of trimorphic foliage, the primordial leaves immediately following the cotyledons are concrescent, widely spreading and linear; those on the main stem or leader-shoots are oblong acute, and much longer than those on the side branches, which are ovate, acute, densely packed, and appressed.

In the ordinary form of *Cryptomeria japonica* the concrescence of the base of the leaf is very marked; but there are varieties in cultivation analogous to the so-called Retinosporas, in which the foliage over the whole tree is of a different character to that of the type, as in *C. elegans*, *C. Lobbii*, and *C. torta* of gardens. The cones of *C. elegans*, a form analogous to *Retinospora squarrosa*, do not materially differ from those of the type, nor does the anatomical construction of the leaf (apart from difference in the shape) differ from that of the normal type.

The internal structure of the two forms of leaves is, indeed, practically the same, except that the stomata are usually much more abundant on the spreading than on the appressed leaves. The stomata often occupy a relatively large triangular area at the base of the spreading leaves. This circumstance leads to the conjecture that one purpose of the presence of these spreading leaves is to secure a freer access of light and a fuller elimination of gases through the stomata, and that they may in some way act, as in facilitating the storage of nutritive matter of which the quickly growing extension shoots may avail themselves (see *antè*, p. 249).

Relation of Protomorphic Leaves to Congenital or to External Conditions.

The appearance of these protomorphic or primordial leaves in the adult condition and their persistence in Retinosporas can only be attributed to an arrest of development, or to the absolute non-occurrence of developmental changes. It is interesting to correlate these forms of leaves with the relatively slow growth of the branches and the disposition of the stomata, the different position and grouping of which as compared to that in the ordinary leaves, points to some functional diversity.

The relation between the primordial and less highly specialized leaves and those which characterized their progenitors is an interesting subject for enquiry, but one upon which as yet little but conjecture can be hazarded.

The superficial resemblance of the primordial leaves to those

of *Lycopodium* and *Isoëtes* is obvious. In fossil plants referred to *Libocedrus*, *Glyptostrobus*, *Callitris*, *Cyparissidium*, and other genera from geological formations of different epochs, the same pleiomorphism in the foliage may be observed as in existing genera. It is therefore probable that these diversities in foliage are not so much the result of direct inheritance from an ancestral condition, or of a sudden reversion to it, as of some circumstances which at one time arrest, at another stimulate development and growth. If this be so, the primordial or protomorphic leaves are the outcome of a similarity in the environment, common alike to archaic and to existing time. This is borne out by the fact that where growth and development are both very rapid, as in those precocious buds which develop into shoots during their first season of growth, or those which result from injury, such as the removal of the terminal bud by the pruning-knife or otherwise, there the bud-scales exist in the form of primordial leaves.

Leaves on the Fertile Branches.

Apart from the occasional transitions to be met with between the ordinary foliage-leaves and those of the male or female flowers respectively, perfectly formed leaves may be found on the cone-bearing shoots of a different form to those on the barren shoots. This happens in some silver firs, as *Abies amabilis* and *A. subalpina*. In *A. firma* the leaves on the fertile branches are different both in form and internal construction from those on the sterile one; thus, in the form of the Japanese *A. firma* known as *bifida* the leaves are longer and deeply notched and the resin-canals are subepidermal, whilst in the typical *firma* the leaves are shorter, blunter, and the resin-canals are in the centre of the mesophyll. As each form of leaf occurs (for a time at least) on particular trees to the exclusion of the other, it is no wonder that they were considered to characterize two different species, *A. firma* and *A. bifida*; but cones have never been observed on the latter. On the other hand, the late Mr. John Veitch, Mr. Maries, and others have settled the question by the discovery, in Japan, of the two kinds of leaves growing on the same branch. Indeed, on the leader-shoots of trees growing in this country, leaves of the two forms may be seen on the same shoot, bifid ones below, entire ones above *.

* Masters in Journ. Linn. Soc., Botany, vol. xviii. p. 514, where references to the literature of the subject are given.

Sometimes leaves of a primordial character occur even on the fruiting-branches; thus, in *Juniperus conferta* or *J. taxifolia* it is common to see fruits borne on branches covered with linear leaves, and I have latterly seen a bush of *Retinospora squarrosa* (a form of *Thuya pisifera* with primordial foliage only) covered with cones.

Concrescence or Inseparation.

One of the most common causes of heteromorphy in the foliage of Conifers arises from the so-called "adnation" or "decurrence" of the leaves. These terms, however, as has been already mentioned under the head of the Cotyledons, are misleading, inasmuch as they imply a previous isolation and subseqnent union. The apparent union is the result of a continued connection between the base of the leaf and the branch from which it springs, instead of a separation or detachment such as usually takes place. It is, in reality, due to the arrest or non-occurrence of developmental changes, coupled often with an enhanced degree of mere growth. The leaf is an outgrowth from the superficial part of the axis, consisting in its fully developed state of cellular tissue, encompassed by epidermis and traversed by fibro-vascular tissue. The cellular and fibrous elements either become detached from the axis at about the same level or at considerably different levels. The term concrescence, as used by Van Tieghem, is more in accordance with the actual facts of the case. The degree of concrescence varies greatly, the species of *Frenela* and *Callitris* being especially remarkable for the extreme degree to which the apparent union is carried *.

Among the Lycopodiaceæ, *L. casuarinoides* is noteworthy for the resemblance in the arrangement of its leaves to that of *Callitris*. In the "pulvinus" of *Picea*, the cellular portion, though not fully separated, becomes prominent at some distance beneath the point where the vascular cords leave the axial cylinder; hence a section of the pulvinus shows it to be cellular for nearly all its length and to be rather a production from the cortex than an essential part of the leaf †. The pulvini therefore require to be distinguished from ordinary "decurrent"

* See Parlatore, Studi Organograﬁce .... delle Conifere (1864), tab. 3. f. 45.

† Masters in Journ. Linn. Soc., Botany, vol. xvii. p. 547 (1879).

or concrescent leaves, and which have nearly the same structure as the free leaves. Thus a cross section of the concrescent appressed leaf of a Juniper shows the dorsal or outer surface to be convex with a central depression. The epidermis is without stomata, next to it is a layer of hypoderm-cells, followed by palisade-cells filled with chlorophyll, and these by loose parenchyma, through the centre of which runs the fibro-vascular bundle. Near the upper or inner, more or less appressed surface chlorophyll-cells again appear, but less regular in shape and dimensions than those beneath. There is no hypoderm, and stomata are wanting except in a central spot marked by glaucous bloom at the base of the leaf. In these leaves, then, the palisade-cells are on the dorsal surface, which, owing to the position of the leaf, is most exposed to the light, and the stomata are on the upper surface.

The relatively free leaves have essentially the same structure. If the bud, say of a Juniper or a Cryptomeria, be examined in the young state, the three leaves of which it consists will be found free at the base. Hitherto growth and developmental change in axis and leaf have been uniform and proportionate; but after a short time the basal portions are uplifted with the stem in its upward grówth, so that the term "decurrent" really conveys an idea the exact reverse of the truth.

It is moreover obvious that, in *Juniperus*, *Thuya*, *Dacrydium*, &c., the concrescent leaves are more especially (but not quite exclusively) found on the more rapidly growing shoots, those which may be conveniently called, in gardener's phraseology, "extension shoots," to distinguish them from the more slow-growing framework shoots, and on which the leaves are free at the base owing to the more uniform and regular progress of development. In a young plant of *Frenela*, preserved in the herbarium of the British Museum, the cauline leaves are all free, acicular, and spreading, but when the stem commences to branch the leaves are seen to be concrescent. Meehan * considers that this concrescence, or adnation as he terms it, is specially characteristic of vigour, while free leaves indicate a state of weakness and arrested growth; and in a sense this is true, for it is generally on the rapidly growing extension shoots that the concrescent

* Proc. Acad. Nat. Sc. Philadelphia, 1868, p. 181; 1872, p. 33; and Proc. Amer. Soc. Adv. Science (1868), Chicago; see also Pasquale, 'Della eterophyllia nel *Cupressus funebris*,' Napoli, 1872.

leaves occur. But if the distinction between growth and development be kept in mind, it would seem that the concrescence is an indication of arrested and irregular *development* associated with disproportionate rapidity of *growth*. In the free leaves the balance between growth and development is preserved, the base of the leaf is symmetrical and the parts are all in regular proportion. It is worthy of incidental mention, with reference to the possible genealogy of Conifers, that some species of *Lycopodium*, as *L. annotinum*, and *Chamæcyparis* have concrescent leaves and projecting pulvini.

In some cases all or a large proportion of the adult leaves are concrescent, as in *Cupressus nutkaensis*, *Callitris*, *Frenela*, &c. In other instances the concrescence is much more apparent in the lateral than in the median leaves, *e.g.* in *Libocedrus chilensis*, *L. austrocaledonicus*, *Cupressus Lawsoniana*, many Retinosporas, &c., where the branch system is flattened, and where, as already mentioned, the leaves are regularly arranged in decussate pairs. Here there appears to be a relative excess or greater rapidity of growth in the lateral pairs of leaves, alternating regularly with a diminished intensity of growth in the median pairs of leaves. In many of these cases, where the leaves are in decussate pairs the free tips of the lateral leaves are in close proximity to the corresponding tips of the median leaves. This proximity is misleading; thus, in *Thuya gigantea*, *Libocedrus decurrens*, or any similar plant, if we fix upon a median leaf, or a pair of median leaves, as a starting point, it will be found on examination that the leaves next in order of time or origin to those from which we start are not those which are nearest, but those which are removed to some distance by the uplifting process, and conversely that the pairs of leaves nearest to those taken as the starting point are further removed in sequence of production. In other words, the closest fellowship is between any given pair of leaves and the lateral pair above them, not between those which happen to be almost on a line with them. On the long fast-growing leader or extension shoots the degree of concrescence and the rapidity of growth are more nearly equal in the lateral and in the median leaves.

Secondary Leaves of Pinus.

The "needles" of *Pinus*, like those of *Sciadopitys* (which will be treated of in another section), have been considered by some

as foliar, by others as axial. Thus Tristan considered the "needles" as abortive branches, a view at one time adopted by Meehan, but since renounced in favour of the view that the fascicle consists of true leaves emerging from the side of an arrested shoot bearing a "dormant bud at the apex" *.

The fascicles of leaves originate within the axil of a bud-scale or of a protomorphic leaf. This position then indicates their bud-like character. If examined in a very early stage of growth, they will be seen to consist of an axis whose growth in length is arrested but which produces at the base two lateral and five, six, or more sheathing-scales of perular nature surrounding a number of tubercles (2–5), which it is easy to trace in different buds from the initial stage to that of the perfectly developed needle or leaf. The perulæ are arranged in spirals, while the needles are verticillate. The number of leaves in a verticil varies from 2 to 5, rarely one only is produced, but this solitary condition is rather apparent than real †. The form of the leaves varies according to the number in each verticil, being plano-convex where there are two only, triangular in other cases.

In tracing the development of the several fascicles of leaves along the whole length of a young shoot, although of course the youngest are nearest the apex, yet it is remarkable how nearly of the same size and stage of development are all the fascicles.

Occasionally it happens that the growing point at the apex of the contracted branch, instead of remaining dormant, is prolonged into a shoot with primary leaves and leaf-buds, see fig. 9.

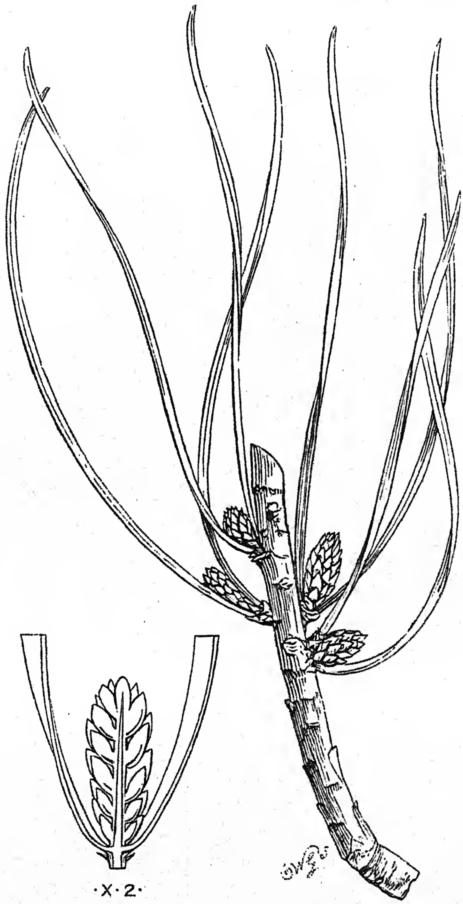
The anatomical structure of the needles of *Pinus* varies slightly in the different species, and has, as also that of the primordial leaves, been already alluded to in a former page. It may suffice here to say that in all essentials the structure is that of the leaves with the xylem part of the bundle directed upwards and inwards.

The evidence derived from comparative morphology, including teratology, development, and minute anatomy, is entirely in favour

* Tristan, *l. c.* p. 246; Meehan, on the Leaves of Coniferæ, Proc. Amer. Assoc. Adv. Science (1868), B, p. 1, also in Proc. Acad. Nat. Sc. Philadelphia, May 14 (1868), p. 122, Journal of Botany, vol. viii. (1870), p. 133, and Bulletin of Torrey Botanical Club, August 1885, vol. xii. p. 82.

† Kronfeld, "Bemerkungen über Coniferen," quoted in Botan. Centralblatt, n. 3, 1889, p. 66, cites instances of variations in the number of leaves in the fascicles of *Pinus*.

of the view that the "needle" of *Pinus* is a true leaf borne upon a shoot whose apical development is usually arrested after the formation of the verticil of leaves *.



·X·2·

Fig. 9.—Terminal shoots of *Pinus* developed between the two leaves of a fascicle.

* See Henry "Beiträge z. Kenntn. d. Laubknospen," *l. c.* tab. xii. fig. 34 (1837); Meehan in Torrey Botanical Club Bulletin (1885), p. 82. Masters in Gard. Chron. (1885), fig. 171. Dickson on the development of bifoliar spurs into ordinary buds, Bot. Soc. Edinb. (1885), Feb. 12.

Monophyllary Pines.

In one form of *Pinus silvestris* the leaves are apparently solitary, but this appearance arises from the cohesion of one leaf to another, and the attachment is usually so slight that the two

Fig. 10.—*Pinus monophylla*, showing on the right the primordial, and on the left the adult foliage, with sections of free and of coherent leaves.

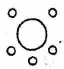
may readily be separated. In *Pinus monophylla* or *Fremontiana* the same cohesion between two leaves occurs; but in this plant some of the leaves are, in the adult condition, really solitary, terete, and with a circular pericycle.

An examination of the mode of development shows that there are always two foliar tubercles, only one of which is developed, while the other becomes obliterated *. In other cases, as above stated, both leaves are formed, but remain coherent by their edges so as to appear simple.

Fascicled Leaves of Cunninghamia.

Bertrand † records an instance in which the leaves of *Cunninghamia sinensis* were fascicled like those of *Pinus*. A short shoot was developed in the axil of the leaf; the lower leaves of the shoot were scaly and formed a sheath; the terminal (fascicled) leaves were very narrow and of the same structure as the ordinary leaves, but destitute of resin-canal and also of stomata.

BUDS AND BRANCHES.

Arrangement.—The buds of Coniferæ do not differ essentially from those of other plants in position or arrangement. The very marked peculiarity of the ramification depends, as will be presently shown, mainly on the alternate development and non-development of the buds. A very common feature in the arrangement of the buds is the development of one apical bud at the end of the shoots, whether terminal or lateral, and of a circlet of lateral buds around it at its base. In the erect leader shoots the circlet is complete ; but in the lateral branches it usually happens, as seen in the species of *Abies* and *Picea*, that the uppermost buds of the circlet, if developed at all, remain in a rudimentary condition, thus . This is evidently connected with the horizontal position of the branches; but it is curious to note that the uppermost buds, those most

* Engelmann in Wheeler, Report, vi. p. 259, Botany of California, ii. (1880), p. 124; Bertrand in Ann. Sc. Nat. tom. xx. (1874), p. 102, tab. ix. figs. 5, 6. Hooker in Gard. Chron. (1886), July 31, p. 136; Masters in Annals of Botany, vol. ii. (1888), p. 126 (anatomy and development).

† Bertrand in Ann. Sc. Nat., Bot. sér. 5, vol. xx. p. 113, t. 11. figs. 4, 5.

exposed to the sun, are not developed but are checked in their growth to the advantage of the lower buds.

In *Pinus*, on the other hand, the lateral buds in the first instance are erect like the terminal bud; but as they grow they assume a horizontal direction, as in the species of *Abies*, but with this important exception, that they generally turn up at the tips as growth goes on, and thus allow of the access of light to the branches beneath. Hence in *Pinus* we find the circlet of buds, whether on the terminal or on the lateral shoots, complete and equally developed on all sides. The relative absence of lateral buds, except near the ends of the shoots, is also a marked feature in the Abietineæ.

Morphologically the bud is simply the apex of the shoot, and in which longitudinal growth is temporarily checked. This arrest is frequently accompanied by a corresponding check in the growth and in the development of the leaves, which assume the form of perulæ or bud-scales, the perulæ being dilatations of the petiolar part of the leaf. In the unexpanded bud the perulæ are free at the base, but as the shoot lengthens they are sometimes cast off, sometimes remain attached to it, in which latter case they are uplifted with the growing shoot.

Intermediate stages may often be found between the perulæ and the primordial leaves, showing the homology of the two as further illustrated in a former paragraph.

In those cases where there is arrest of growth unaccompanied by corresponding arrest of development as in the Cupressineæ, the buds are scaleless or naked.

The bud-scales are arranged spirally and are frequently compacted together by a felted arrangement of the hairs or fringed margins of the scales as in many Pines, or by an exudation of resin as in many Firs. These arrangements are evidently adaptations for the protection of the young buds from cold or wet. In some species of Spruce (*Picea*) additional protection is afforded by the arrangement of the leaves near the end of the shoot, and which, instead of spreading laterally, are directed vertically parallel to the long axis of the shoot and thus close over the buds. The form of the buds and bud-scales affords useful means of discrimination between certain species. Thus the long thin pointed bud of *Pseudotsuga Douglasii* is characteristic of that species, while in various species of *Abies* it

is conoidal or globular, in Pines cylindric, domical, acuminate, covered with resin or not, and so on.

In most species of *Abies* and *Picea* the bud-scales are more or less coriaceous and oblong; in *Pinus* there is a "mother" scale succeeded by two lateral scales at the base, followed in spiral order by 5 or 6 or more scales, which present great variations in texture and duration, being long, thin, and membranous in *P. Cembra*, *P. excelsa*, &c., prolonged into a long acumen in *P. Coulteri*, subcoriaceous and entire in *Picea polita*, &c., or papery and lacerate at the edges, straight or ultimately revolute at the tips, as in *Pinus Bungeana* and *P. monophylla*, &c.

As these perulæ serve a uniform and a temporary purpose only they are less liable to variation and modification during growth from the operation of external causes than organs of longer duration and more complex function, and hence from their relative invariability their utility for classificatory purposes is greater than might at first be supposed *.

Deperulation.—The manner in which the bud-scales are removed or thrust aside by the growing shoot is also worthy of attention. The variations observed depend of course on the relation between the nature of the scales, the amount of resistance they offer, and the degree of vigour and direction of growth in the bud beneath. The "characters" so afforded supply indications of a general tendency rather than of absolute constancy. In some cases the bud-scales are least resistent to the pressure of the growing shoot at the apex of the bud, in which case the shoot makes its way through a ring or tube of scales which persists around the base of the branch for a long period. This method of deperulation may be called tubular. Illustrations of it occur in *Abies amabilis*, *brachyphylla*, *bifida*, *Veitchii*, *homolepis*, *cephalonica*, *nobilis*, *magnifica*, *Lowiana*, *concolor*, *Pinsapo*, *bracteata*, *Fraseri*, *Pseudotsuga Douglasii*, *Picea ajanensis*, *polita*, *rubra*, *nigra*, *Engelmanni*, *Morinda*, *Menziesii*, and most species of *Pinus*.

* The phyllotaxis of the bud-scales is treated of by Henry in his classical paper entitled "Beiträge zur Kenntniss der Laubknospen," in Act. Acad. Nat. Cur. xix. p. 1 (1837), c. tab.; see also Eichler, Entgegnung &c. in Sitzungsb. d. Gesellschaft Naturf. Freunde zu Berlin, June 1882, p. 90. The adaptation of the bud-scales to climatal conditions is the subject of a paper by Grüss, "Die Knospen Schuppen d. Coniferen u. deren Anpassung an Standort und Clima," Berlin, 1885, a paper, however, of which I have only seen the title.

Menge, "Ueber d. Blattscheide der Nadeln von *Pinus silvestris*."

In other species the bud-scales are least resistant at the base of the bud, and when this happens the bud-scales are pushed off in the form of a cap. This may be called calyptrate deperulation. A prevalent tendency to calyptrate deperulation is

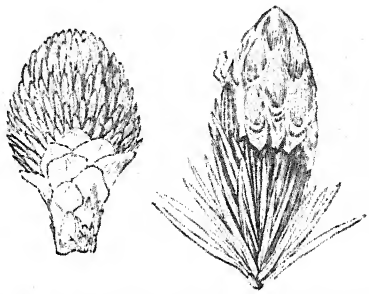


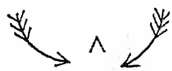
Fig. 11.—Tubular deperulation to the left; calyptrate to the right.

observable in *Abies sachalinensis*, *Picea pungens*, *Engelmanni*, *obovata*, *Morinda*, and *rubra*, rarely if ever in *Pinus*. But the tendency is inconstant even on the same tree, being dependent, as before said, upon fluctuating conditions. In *Picea Engelmanni*, while the deperulation of the lateral buds is calyptrate, that of the terminal ones is usually tubular.

The order of development of the terminal and lateral buds at the ends of the erect or of the horizontal shoots is worthy of attention. The general but not invariable tendency in the Abietineæ is for the side-buds to expand before the central or terminal bud, even when that is larger than the other. This may possibly be partly accounted for by the restriction afforded by the circlet of buds around the end-bud.

In some of the Pines where the cone is apparently, though not really, terminal, the central bud does not start into growth and develop into a shoot until the originally erect cone bends downwards; hence the shoot in question is a season behind the cone in development though formed at the same time.

The direction of growth of the young shoot also presents (*in the first instance*) differences in different species according as the side shoots turn from the horizontal position upwards or downwards; thus in *Abies Nordmanniana*, *A. homolepis*, and many others, the side shoots at first grow more freely on the lower surface (hyponasty), whence it happens that the lateral shoots are curved in

an upward direction,  leaving the as yet undeveloped central bud as it were at the bottom of a cup. In other cases the curvature of the young shoot is downwards owing to disproportionately rapid growth on the upper side of the shoot (epinasty), and in consequence of which the tip of the shoot is directed downwards, . This happens in *Abies Veitchii*, *sachalinensis*, *Picea Engelmanni*, *Morinda*, *excelsa*, *ajanensis*, &c.

These remarks only apply to the direction of the shoots in the first instance; during growth the originally upturned shoot becomes inverted and *vice versâ*.

In the *Piceas*, where the young shoots are at first deflexed, the stomata are not so distinctly localized in position. In any case, whether the side branches be at first curved upwards or in the opposite direction, growth becomes ultimately equalized on the two surfaces, and the branches then, after various changes of position, assume a straight and nearly horizontal position.

In *Pinus* the shoots turn upwards almost from the first, and are directed nearly in a straight direction. After a time the lateral shoots become more or less horizontal, except at the tips, which become curved upwards.

In *Pinus* also the young shoots present differences which are useful for specific distinction, in colour, degree of hairiness, form, &c., some being cylindrical, others with prominent angles, with intervening furrows, with one or more rows of resin-canals; but the most remarkable difference here to be noted is the presence or absence of leaf-fascicles at the base of the shoot. Where the growth is uniform the whole length of the shoot is covered with leaf-tufts as in *Pinus Pinea*, *resinosa*, *Laricio*, *silvestris*, *pungens*, *contorta*, *inops*, *densiflora*, *Llaveana*, *hudsonica*, *Cembra*, *ponderosa*, *edulis*, *rigida*, *Pumilio*, &c.; but where growth is disproportionately rapid near the base there the base of the shoot is destitute of leaves for some distance, as in *Pinus Strobus*, *monticola*, *Sabiniana*, *excelsa*, *Peuke*, *Jeffreyi*, *densiflora*, *Bungeana*, *muricata*, *tuberculata*, *monophylla*, *pyrenaica*, *Parryana*, *Massoniana*, *mitis*, &c. This character, however, is

no more absolute than any other, for in *P. montana* (*uncinata*), while the central shoot is leafy to the base, the lateral shoots from the same cluster of buds are naked at the base.

The shape of the young shoot soon after its emergence from the bud is sometimes the same as at a later period, as in *Picea*, where the shoots retain the cylindric shape they had at first; while at other times the shape of the shoot differs from that which it assumes when the leaves are fully expanded; for instance, in *Abies firma* and *A. homolepis* the young shoot as it emerges from the bud is spindle-shaped or cylindric, with the leaves appressed to the axis on all sides, thus exposing to the light their stomatiferous or lower surfaces. As growth goes on the leaves, though really in many rows, arrange themselves in one horizontal plane and become pseudo-distichous, some of them, according to their place of origin, becoming twisted at the base so as to allow of the exposure of the upper surface to the light, while other leaves differently placed require no such torsion.

Spurs.—The species of *Larix*, *Cedrus*, *Pseudolarix*, and *Ginkgo* are remarkable for the production of two kinds of branches, the one long and slender with the leaves distributed at intervals, the other short, thick, with the leaves in tufts at the extremities. The former are the extension or leader shoots in which growth and development are rapid; the latter are analogous to the similar growths in the Apple, Pear, Laburnum, &c., but are (in the Conifers) not necessarily connected with the development of fruit, although in *Pseudolarix* and *Ginkgo*, however, the spurs bear the male flowers. In the Larches and Cedars the "spurs" either remain as such or lengthen ultimately into extension-shoots. The leaves on the extension-shoots are generally longer and more glaucous than those on the spurs, and are stomatiferous on both surfaces.

The mode of development of the spurs may readily be traced in the Larch or Cedar, and confirms the view that the appearances are due to the more vigorous growth of the basal and peripheral parts in comparison with the central and apical portions. Thus if the bud at the end of a shoot be examined in October the apex will be found to be dome-shaped. The young leaves emerge in succession from the base of the dome leaving the apex naked, so that the development of the leaves is centripetal.

If one of the lateral buds be examined at the same time, the axis will be found to form not a dome but a cup from whose margins the leaves protrude, those at the upper edge of the cup being the oldest and corresponding to those at the base of the dome. These lateral buds are those destined to form the tufts of leaves on the spurs. The greatest energy of growth is in the one case at the apex of the growing axis, in the other at the base.

Cladodes or Phylloclades.

The peculiar flattened, often lobed and branching expansions in the genus *Phyllocladus* originate in the axils of scale-like perulæ or of linear primordial leaves similar to what may be observed on the seedling plant in succession to the cotyledons. Their position and anatomical structure leave no doubt as to their true morphological nature as branches of a peculiar character.

The leaves are concrescent with the cladode, and their arrangement is described by Van Tieghem as distichous, concrescent with each other in each row and with the branch, so as to form with it a single flattened branch toothed at the edges. In the upper part the cladodia are arranged spirally in more than one plane.

The fact of a branch originating from the axil of a rudimentary leaf, producing a green leaf or a small number of green leaves and then ceasing to grow, is compared by Van Tieghem to what takes place in *Sciadopitys* *, wherein the leaves are inseparate or concrescent and form a single blade or needle, which has its dorsal surface (phloem) upwards and its ventral or xylem surface beneath.

"*Needles*" *of* Sciadopitys.—Functionally these structures are leaves, morphologically they present greater resemblance to axial structures. They occupy the axils of leaves of the first order, and thus correspond in position with the fascicle of leaves in *Pinus* or the seed-scale in the cones of Abietineæ.

If examined in the bud-stage, each appears as a tubercle notched at the apex and placed in the axil of a perula which is clearly homologous with a leaf. After the formation of the notch at the apex no further growth in that situation occurs, subsequent increase taking place by intercalary additions at the base. The

* See Van Tieghem, Traité de Botanique, p. 1321.

whole bud is of a globose form; and if a vertical section be made of it, the axis will be seen to terminate in a dome-shaped process from the sides of which emerge the perular leaves, each with a "needle" in the axil. Strasburger describes these perulæ as traversed by a single mesial bundle, and this is probably true, although in many cases I have found the structure to be wholly cellular. A vertical section through the perula and the needle shows the two to have a common cellular basis, so that it is not possible to say where the one ends and the other begins. The needle is longitudinally grooved in the centre of both upper and lower surface, the furrow being deepest on the lower surface. It is traversed by a double vascular bundle, and on microscopic examination the structure is seen to consist of a bounding epidermis with subjacent hypoderm, palisade-tissue traversed by resin-canals, each surrounded by strengthening-cells and overlying a ground-tissue consisting of what Von Mohl designated transfusion-tissue with large isolated stelliform sclerotic cells. In the centre are two bundles each with its own bundle-sheath.

The pericycle consists of small, globular, closely-packed cells; the xylem is on the underside (contrary to what happens in a true leaf), its rays running obliquely upwards and outwards from the base. This oblique position of the xylem is a fact of some interest in connection with that interpretation of the nature of the seed-scale of Abietineæ which postulates the presence of two leaves arising from a contracted or undeveloped axis and having a direction like that of the vascular bundle of *Sciadopitys*.

With regard to the two-fold nature of the bundle in *Sciadopitys*, it may be pointed out that a similar two-fold or two-branched bundle occurs in numerous species of *Pinus*, *Picea*, *Abies*, &c.; but in these cases there is but one bundle-sheath encircling the two divergent masses of xylem and phloem, while in the seed-scales of Abietineæ no sheath at all is observable. The situation of the xylem at the lower side of the needle and its divergence from the lower surface ${}^{p}\searrow_{x}\ {}_{x}\nearrow^{p}$ are in marked contrast to the position of the same elements in the leaves of *Pinus*, in which the xylem is beneath the upper surface ${}_{p}\nearrow^{x}\ {}^{x}\searrow_{p}$ and the two divisions converge from the base.

The different opinions held with regard to the morphological

nature of the needle of this plant may be classed under three heads, according to which the needle is (*a*) foliar or conjointly foliar and axial, (*b*) wholly axial or cladodian, (*c*) an enation from a true leaf.

In spite of the peculiar position of the liberian and of the vascular elements of the bundle, Von Mohl* considered the needles as leaves and compared them to the seed-scales of the Abietineæ, in which the same relative position of the elements occurs. Mohl's explanation is that the needle consists not of one, but of two leaves belonging to an abortive shoot axillary to the primordial leaf as the seed-scale of the cone of Abietineæ is to the bract. He accounted for the peculiar position of the xylem and phloem by supposing that the union of the two leaves took place by the margins directed towards and adjacent to the main axis, so that the under surface, and consequently the phloem, came to be directed towards the axis and the upper, or xylem, surface in the opposite direction.

This may be represented by the annexed diagrams:—

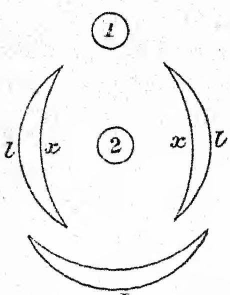


Fig. 12.

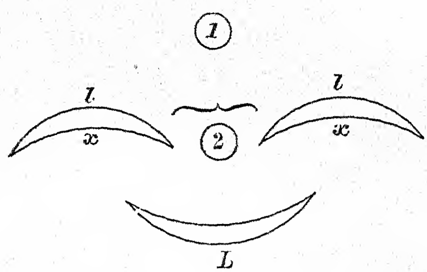


Fig. 13.

For explanation, see text.

wherein the circles marked 1 represent the main axis, those marked 2 the secondary axis, with the mother leaf *L* below and the two secondary leaves *l*, *l*, one on each side of the secondary axis. In fig. 12 the lateral leaves *l*, *l* are represented in their natural position, and the xylem *x* also. In fig. 13 the secondary lateral leaves *l*, *l* are indicated in union by their posterior

* Mohl in Botan. Zeitung (1871), p. 101.

margins and dragged out of position, with the result of displacing, or apparently displacing, the xylem and the phloem.

Engelmann *, Strasburger †, and Van Tieghem ‡ also consider that the needle is due to the concrescence of the two leaves which spring from an axillary shoot, the development of which is arrested so that no trace of a *punctum vegetationis* or growing-point can be seen in the adult condition. It may be added that no trace whatever of the supposed axillary shoot can be seen at any period by microscopical examination of the buds, nor any evidence of the torsion and displacement of the leaves.

Bertrand § considers the needles to be axes with a bilateral symmetry and compares them with the bud (seed-scale) developed in the axil of the bract of the cone of Abietineæ. Čelakovsky (*in litt.*) also considers the double needle of *Sciadopitys* to be the morphological equivalent of the seed-scale of Abietineæ.

The late Prof. Dickson thought that the needles represented phylloid shoots or cladodes like those of *Ruscus* rather than leaves ‖. "There is nothing," he says, "in the developmental evidence to prove that the arrested *punctum vegetationis* is not at the apex of the organ between the two projecting points, and if it be at the apex then the organ must be regarded as a cladode." Dickson was confirmed in his opinion by the occasional development of branches from the notch of the needle, as first observed by Carrière ¶, the branching being due to the renewal of growth at the apex, where it usually remains arrested. Dickson, like all other observers, points out that the position of the xylem and phloem is the same in the needles of *Sciadopitys*, the cladode of *Ruscus*, and the seed-scale of the Abietineæ. Bower also describes the cladode of *Ruscus* as growing in a similar manner to that described in *Sciadopitys*.

Goebel adopts a similar view to that of Dickson, pointing out

* Engelmann in Sitzb. Ges. naturforsch. Freund. Berlin (1868), p. 14.

† Strasburger, Conif. und Gnetac. (1872), p. 382.

‡ Van Tieghem, Traité de Botanique (1884), p. 1320.

§ Bertrand in Ann. Sci. Nat. (1878), t. xii. p. 67.

‖ Dickson, "Phylloid Shoots of *Sciadopitys*," Report Internat. Bot. Congress, London (1866), and Journal of Botany (1866), p. 224; "Foliage-leaves of *Ruscus*," Trans. Bot. Soc. Edinb. xvi. (1885), p. 140, t. ix.–xi. See also for *Ruscus*, Van Tieghem, in Bull. Soc. Bot. France, Feb. 22, 1884.

¶ Carrière in Gard. Chron. (*ex* Revue Horticole), May 2, 1868, and March 1, 1884.

that the position of the xylem is wholly exceptional, if the needle is to be considered foliar *.

Eichler (*in litt.*) looked upon the double needle of *Sciadopitys* as an enation from the primary leaf and extended the same interpretation to the seed-scale of Abietineæ, as will be mentioned hereafter.

The evidence derivable from comparative morphology, teratology, and anatomy is summarized in an article in the 'Journal of Botany' by the present writer †. The suggestion may be made that the needle is a shoot, the distal or anterior portion of which (in relation to the axis) is abortive, just as the leaf is considered by M. Casimir de Candolle to be a branch the proximal or posterior part of which is not developed ‡. In *Sciadopitys*, according to this view, the cladode would consist of two branches, or of two shoots, in union side by side as far as the notch, the leafy dilatations on each side of the central groove would be simply flattened axes, not displaced leaves, and the occasional presence of a bud at the tip would be only an accidental occurrence and one which in any case would not invalidate the axial nature of the cladode.

The subject must necessarily be referred to again in treating of the seed-scale; but it may here be remarked that all the authors, whatever view they have adopted as to its morphology, consider the double-needle of *Sciadopitys* as the homologue of the seed-scale of Abietineæ. The absence of a bundle-sheath in the seed-scales may, however, be cited as one point of difference.

Ramification.

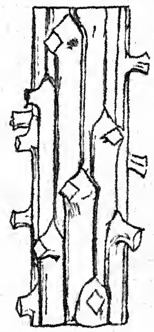
One of the principal peculiarities of the branches and stems of Conifers arises from the presence or absence of prominent swellings or "pulvini" (fig. 14). In the species of *Picea* and of some of the species of *Pinus* the base of the leaf is, as it is called, "decurrent," the cortical tissues being thickened and forming peg-like projections (see p. 264). In *Abies* and in the

* Goebel, Enc. d. Naturwissensch. 1883, p. 216. See also Bower in Proceedings of the Linnean Society, March 6, 1884.

† Masters, "On the Comparative Morphology of *Sciadopitys*," in Journal of Botany, April 1884.

‡ Casimir de Candolle, Théorie de la feuille (1868).

Strobus and *Cembra* sections of *Pinus* the cicatrix left by the leaf is in the form of a shallow circular rim.



X·2

Fig. 14.—Pulvini of stem of *Picea*.

The mode of branching in the Conifers is often so distinct in appearance as to give rise to the impression that there must be some essential difference between the ramification of these and that of other plants. This, however, is by no means the case.

It is always monopodial, never sympodial or dichotomous. The variations depend primarily upon the development of the buds in particular situations and upon their non-development in others. Development and non-development occur in rhythmic alternation as regards time, and in relatively definite positions as regards space *. The unusual degree of regularity with which these phenomena do or do not occur brings about a style of ramification characteristic indeed, but still not essentially different in kind from that which occurs in many other plants.

In many Conifers the relatively large development of the trunk as compared with that of the branches, the apparently verticillate arrangement of the latter, their spreading direction, and their gradual diminution in length from below upwards, give rise to a tree of markedly pyramidal form. The virtually verticillate arrangement of the primary branches is associated with a bilateral disposition of the branches of lower order and with a like arrangement of the leaves.

In other cases, where the disproportion between the stem and the main branches is not so great, we have, as in many Pines, Yews, &c., the bush form, and this becomes modified into the flame-shaped form, as in various Thuyas and Cypresses, the columnar form, as in young plants of *Libocedrus decurrens*, and the globose form, as in varieties of *Thuya orientalis*, &c. Fastigiate forms like the Irish Yew owe their appearance to the general upward direction of their branches. This upward direction is due to the retention in adult life of the juvenile mode of growth. Correlative changes are observable in the arrangement of the leaves, which do not in these cases become twisted at the

* See Sachs's Text-book, ed. Vines (1882), p. 239; Goebel, Outlines, ed. Garnsey and Balfour (1887), p. 320.

base, but retain their many-ranked arrangement and do not become pseudo-distichous, and in the size of the leaves, which is generally less than usual. The total leaf-surface may indeed not be actually less than in the ordinary form, but it is more broken up and scattered to secure insolation from various directions, whereas when the leaves are arranged in two groups in one horizontal plane, the exposed surface lies in the same plane to fit the circumstances.

Schübeler * figures a lofty tree of the Common Spruce in which the lateral branches, instead of being deflexed or horizontal, ascend to form an oblong head in place of the usual conical one. Such firs are known to the German foresters as "Spitz Firs."

Pendulous forms are brought about by the downward curvature of the shoots.

Occasionally the branches in one part of the tree are arranged in one direction, while in another the disposition is different. Thus in a tree, a representation of which is given in the 'Garten Flora' for 1887, August 15, the upper branches are bent down against the trunk, while the lower ones spread in the usual manner. It is curious to compare this different arrangement of the branches with the corresponding variation in the direction of the seed-scales of the same cone observed by the late Alexander Braun †.

Great differences of appearance result also from variations in the amount of branching. In the now commonly cultivated *Araucaria imbricata* the amount of branching in the young state is relatively little secondary, the branches being few and far between. In some exceptional forms of the Common Spruce (*Picea excelsa*) this relatively slight degree of ramification produces a remarkable appearance. The slender trunk gives off at remote intervals very long simple branches which hang down; the lower ones, as it were, writhing on the ground like so many serpents, hence the German name of Schlangenfichte. It is interesting to note that in these little-branched trees the leaves are of unusually large size, as if to make up for the small leaf-surface due to the relative scarcity of branches.

Personally I have only seen cultivated specimens propagated by grafting; but the late Professor Caspary, of Königsberg, obligingly informed me that he had seen at various times several

* Schübeler, Pflanzenwelt Norwegens, fig. 32.

† Braun in Sitzungsb. Bot. Verein. Brandenburg, June 26, 1874; scales in upper half of cone deflexed, those in the lower portion ascending.

wild specimens which had originated as seedlings in Prussian forests. One of these was estimated in 1873 to be about 38 years old and was 6–7 metres in height and 7 metres through. Neighbouring trees of the same species and age had branches of the seventh and eighth degree of subdivision, but the variety in question had only branches of the third, very rarely of the fourth order.

A very similar form originated nearly fifty years ago in Mr. Cranston's Nursery at Hereford. To the gentleman named I am indebted for the information that the plant was first observed among a bed of seedling Spruce Firs and was planted out and propagated by grafting*. The occurrence of this form in a bed of seedlings of the ordinary character shows that recent external conditions were not instrumental in producing the variation, else all, or a majority, of the seedlings would have been affected in the same way. The majority of seedlings produced from a tree of this description at Lilienfeld are of the ordinary character, and only a few reproduce the habit of the parent. A tree of similar character exists in the nursery of Messrs. Lucombe, Pince, & Co., of Exeter, and has produced cones one of which was kindly sent to me. It differed in no wise from the common form†.

* Mr. Heale informed me that in 1887 the tree in question at Hereford measured 23 feet 6 inches in height, and about 15 feet in diameter.

† The following references apply to the Snake-fir or similar forms:—Loudon, Arboretum, iv. p. 2295 (*Abies* (*Picea*) *excelsa monstrosa*): Jacques in Ann. Soc. Hort. Paris (1853), vol. xlvii. p. 652 (*A. excelsa*, var. *virgata*): Carrière, Revue Horticole (1854), tom. iii. p. 101; Traité Générale, ed. 2 (1867), p. 331 (*Picea excelsa denudata*): Koch, Dendrologie, ii. (1873), p. 237, wherein numerous references to ancient literature are given: Gordon, Pinetum, ed. 2 (1875), p. 10 (*Abies excelsa Cranstoni*): Caspary in Schrift. d. phys.-ökon. Gesellsch. z. Königsberg (January 14, 1873), 116 ff. 123 ff. (*Picea excelsa*, Link, var. *virgata*): Willkomm, Forstl. Flora, ed. 2, 1886, p. 75. Koch in his 'Dendrologie,' above cited, comprises the vars. *virgata* and *Cranstoni* with the *Pinus viminalis* of Alstrœmer (1777), a form with long, slender, pendulous branches, described by Caspary in Schrift. d. phys.-ökon. Ges. zu Königsberg, xix. (1878), t. 5, as *Picea excelsa*, Link, var. *viminalis*, Casp.; see also in 'Garten Flora,' 1887, pp. 469, 552, 1889, pp. 136, 657: Schübeler, Pflanzenwelt Norwegens (fig. 27, p. 161), figures under this name a form intermediate between those above-mentioned. C. Wilhelm in Sitzungsb. d. k. k. zool.-bot. Gesellsch. in Wien, Bd. xxxvii. (Feb. 9, 1887); Graf, Fr., Berg, "Einige Spielarten der Fichte, Schlangenfichte; astlose Fichte (loosely branched); pyramidale Fichte; Trauerfichte (mournful fir); Hängefichte (pendulous); Kugelfichte (globular); Krummfichte (crooked) or Sumpfichte (swamp-fir); nordische Fichte (*P. obovata*)," Naturf. Gesellsch. f. d. Univ. Dorpat, ii. 8vo, 44 pp.; mit 12 Tafeln, Dorpat, 1887: *ex* Bot. Centralblatt, Band xxxii. 12, no. 51, 1887.

An exactly opposite mode of ramification to that just mentioned occurs in other varieties grown in nurseries, such as the Clanbrassil variety. In these cases the trunk and primary branches remain short and comparatively undeveloped, while the smaller branches are greatly multiplied so as to form a low globose bush. These sports frequently originate as "burrs" or bud-variations from branches of the ordinary character; but when removed they may be propagated by grafting. Similar forms occur in other Conifers, e. g. *Pinus silvestris*, *P. Cembra*, *P. Strobus*, &c., but must not be confounded with the singular outgrowths (*Hexenbesen* of the Germans) which are the result of the attack of a parasitic fungus (*Æcidium elatinum*).

Mention has already been made of the leaves on fastigiate shoots and of the curious tendency that some species of *Abies* have of suddenly producing from the upper surface of their horizontal branches shoots which have an ascending direction and in which the leaves are, in consequence, regularly arranged round the axis as in *Picea Menziesii*, *ajanensis*, &c. Of like character are the remarkable cases sometimes seen in forests where numerous branches rise erect from the lateral branches surrounding the main trunk like so many satellites. In these cases the original radiating position of the leaves has been lost in course of growth and the leaves are arranged on the satellite branches exactly in the same way as on the parent tree. *Abies Pichta* at Pampesford produces shoots of this character which are "layered" and afterwards separated as independent trees.

Loudon, Goepert, and others figure and describe several cases of this kind in the common Spruce, the Yew, the Arbor Vitæ, &c., where the horizontal branches have rooted in the soil and sent up secondary trunks of the ordinary character from the branches.

The two authors last mentioned allude also to analogous cases of the production of erect stems from the prostrate trunks of firs overthrown by the wind, and I have myself seen numerous erect branches proceeding from a felled trunk of *Taxodium sempervirens* which had been allowed to lie on the ground after it had been hewn down *.

* Loudon, Arboretum (1838), vol. iv. pp. 2298 *et seq.*, figs. 2215–2217; Goeppert, Verhandl. d. Beford. d. Garten-Baues in d. k. Preuss. Staaten (1853), i. p. 337, tab. 6. figs. 14–19; Schübeler, Pflanzenwelt Norwegens (1875), p. 164, figs. 28–33.

Adventitious buds are commonly found emerging from the trunk below the lowest branches of *Larix leptolepis*, *Glyptostrobus*, *Pinus rigida*, *P. muricata*, and *P. serotina*. Were such a tree felled doubtless these shoots would assume the appearance and mode of growth of main shoots. Sometimes, after injury by the pruning-knife, or other cause by which the terminal bud is destroyed, lateral adventitious buds are formed which assume an erect direction. I have seen this in *Pinus Coulteri*, *P. excelsa*; whilst the peculiar form of silver fir called *Abies Reginæ-Amaliæ*, a form of *A. cephalonica*, owes its origin probably to a like cause *.

Carrière describes and figures an example of this kind in *Araucaria excelsa*, in which the extremity of one of the side-branches had been cut off, with the result that a new shoot was developed near the cut end and which assumed an upward direction. But this tendency towards the obliteration of lateral shoots as witnessed in the snake-fir, or the proclivity on the part of lateral shoots to assume the direction and form of erect shoots, is by no means universal among Conifers. On the contrary, it is not unfrequently a matter of regret to gardeners and foresters that certain species, such as *Abies amabilis*, *A. bifida*, &c., do not develop leader-shoots, or, if they do, the shoots die, either because they are overpowered by the superior growth of the lateral branches or from other causes. Tying up a lateral shoot so as to make it assume an erect direction is sometimes, but by no means always, successful.

So among the Cupressineæ it frequently happens that lateral shoots struck as cuttings, although they grow vertically, yet do not assume the form of leading shoots, but retain the two-ranked distribution of their leaves and their flattened form. But this is not without exception †.

The arrested development of the terminal buds in Conifers may be compared to the similar arrest that takes place in the vegetative cone of *Welwitschia*.

The relatively feeble development of the terminal, as contrasted

* Heldreich in Regel, Garten Flora (1860), p. 313; Seemann in Gard. Chron. 1861, p. 755; A. Murray in Journ. Roy. Hort. Soc. vol. iii. 1863, p. 144, on the Synonymy of various Conifers.

† Goeppert in Act. Acad. Nat. Cur. (1868), p. 34, t. 1.

with that of the lateral buds, is probably the cause of the peculiar beaded or cupped growth of some Conifers, as in *Abies subalpina*, where the ends of the shoot each year sometimes swell out into well-marked dilatations, or even into cup-like forms, the terminal growing-point being, as it were, included within, or at the base of, the cup formed by the faster-growing side-buds. A remarkable instance of this kind occurred in an *Araucaria* growing in the grounds at Bodorgan, Anglesea, where I had the opportunity of seeing it. In *A. Pindrow* and some others the arrest in development of the terminal bud is a marked feature, and one which interferes with the symmetrical appearance of the tree.

In the Cupressineæ the branchlets or smaller branch-systems are usually flattened either from side to side, or from above downwards. This appearance arises from the production of the branchlets in one plane only, and from the regular conduplication of the lateral leaves (the median ones remaining flat and appressed). In these plants a certain number of branchlets with their leaves have a sort of individuality of their own, so as to resemble compound leaves, the pinnæ being represented by separate branchlets. This individuality is still further indicated by the fact that groups of branchlets, or branch-systems, fall off singly as the individual leaves of deciduous plants do and by a similar process called in this case "cladoptosis" *.

Variations further occur arising from the degree of ramification, as in bi-, tri-, quadri-pinnate ramification. In some cases this pinnate mode of branching may take place regularly on both sides of the branch or on one side only, and in that case generally on the distal side, or that furthest removed from the axis, often (as in *Thuya*) causing a curvature of the branchlet, whose concavity is directed towards the main axis. A similar one-sided ramification is observable in many Algæ, e. g. *Plocamium*.

In further illustration of these remarks examples may be cited in various genera.

Cupressus Lawsoniana has flattened branch-systems placed in a horizontal, in an ascending or in a descending plane in different varieties. The leaves are in decussate pairs, lateral buds being

* Dr. James Stark, "On Shedding of Branches and Leaves of Conifers," in Trans. Roy. Soc. Edinb. xxvii. p. 651, pl. xliv.

formed rhythmically in some of the leaf-axils, while they are undeveloped in others. The sequence of the branches is generally as follows:—Holding a branch in front of one and starting from a median leaf, it will be seen that no branch springs from its axil; indeed, as a rule, the axils of the median leaves, whether anterior or posterior, are empty. The lateral leaf next adjoining on the left-hand side has a branch in its axil, which may therefore be called fertile, while its neighbour on the right-hand side is sterile; the median leaves next above are, as usual, sterile; above this the left-lateral axil is sterile, the right fertile, and so on, the shoots being produced at every second node, now on this side, now on that. Variations of course occur, and the arrangement is masked by the nearly equal size of the main and of the side-shoots which produces an appearance of dichotomy, while the shoots appear to proceed, on the same level, from both right and left axils. If care be taken to distinguish between the leaf produced on the main branch and that on the side branch next in order, which at first sight appear to belong to the same axis, this fallacious appearance may soon be detected. Often, as has been already stated, shoots are produced on the side of the branch nearest to the axis, but only on the off or distal side; hence the branch becomes curved, with its concavity turned towards the main stem. Towards the apex of the branch the shoots are given off on both sides. On the long, quick-growing leader-shoots the degree of concrescence of the leaves is equal in the median and in the lateral leaves respectively; while on the more slowly growing branches the concrescence of the base of the lateral is greater than that of the median leaves.

In *Libocedrus decurrens* the groups of branchlets constituting branch-systems are placed vertically, so that the conduplicate leaves, which are really lateral, are placed with their edges looking upwards and downwards, while the flat median leaves are directed laterally. Branching takes place with much regularity from the axil of one leaf of every alternate pair, that is from the axil of a lateral leaf, first on the left, then on the right, and so on.

Thuya gigantea.—This, as seen in English gardens in the young state, is a pyramidal or flame-shaped tree, with the branch-systems flattened horizontally, rarely vertically. The leaves are tetrastichous and decurrent. The ultimate branches are given off

from the leaf-axils in this order:—(1) median axil sterile, (2) lateral axil sterile, (3) median sterile, (4) lateral fertile, and so on. At the base of the branches the production of new shoots is for some distance confined to the distal side, giving a curved appearance to the shoot, the convexity being to the further, the concavity to the nearer side of the shoot; but towards the middle, and thence onwards to the tip, the branchlets are given off alternately to the right and to the left. Meehan * points out "that in the most vigorous growths of *Thuya gigantea* and *T. occidentalis* a branch appears at the eighth node, and always at the eighth node when the vigour of the branch remains the same. As the axis weakens, the branches appear at the sixth node. . . . With greater weakness, the fourth node gives birth to the branch; and, finally, as the plant takes on its frondose flattened form, a branch pushes from every alternate node. But in no case does a branch push at an odd number; they are always from the second, fourth, sixth, or eighth node."

If for vigour, rapidity of growth on the leader-shoot be substituted, I concur with Mr. Meehan, as my observations tally with his in the main, though there is no absolute rule in the matter; nor, indeed, does Mr. Meehan assert that there is.

Biota orientalis has the branch-systems ascending and compressed from side to side. The leaves are decussate, and branching takes place from each of the lateral pairs, generally only from one axil, the next succeeding branch being given off on the other side; rarely branches are given off from both sides. On the vigorous leader-shoots, according to Meehan, branching takes place from every fourth node.

In *Chamæcyparis sphæroidea*, referred by some authors to *Cupressus*, and included, with *Retinospora*, under *Thuya* by Bentham and Hooker (Gen. Plant. iii. p. 427, 1880), the branching is peculiar, being umbellate or radiating, the main branch-systems in this case not being in one plane, but partially from the median as well as from the lateral leaves, and thus forming inversely pyramidal or wedge-shaped branch-systems, resembling the wedge-shaped tufts of leaves which occur at the ends of the branches of some of the pines, e. g. *Pinus ponderosa*. The penultimate shoots are branched on both sides and compressed, some in the horizontal, others in the vertical plane. The leaves are

* Meehan, in Proceedings Acad. Nat. Sc. Philadelphia, June 25, 1872, p. 33.

uniform and 4-seriate. The branching on the main leader-shoots takes place, according to Meehan, pretty regularly at the fourth node, sometimes from the second, rarely from the fifth.

Thuyopsis dolabrata has very flat branch-systems, the leaves are decussate, and branching takes place from one or both of the third or fourth lateral pairs of leaves above the one taken as a starting-point.

Thuyopsis borealis is, in the young state, a shrub of pyramidal habit, with pendulous flattened branch-systems. The leaves are uniform, in four rows. Branching occurs pretty regularly from one of each of the lateral pair of leaves, now to the right, now to the left, rarely from both sides at the same level. On the main quick-growing shoots, the order of branching, according to Meehan, is the same as in *Thuya occidentalis* and *gigantea*.

"Sometimes in very stout shoots of this plant," says Meehan, "the leaves will be in whorls of three, and then the branching is on the odd numbers 3, 5, 7, but not in a regular graded series as in its normal condition. I have counted as many as fifteen nodes without a branch; and this absence of order in branching exists also in Junipers. In these the leaves are mostly in threes, though still decussate, and the branching takes place at the odd numbers and is irregular. *Callitris quadrivalvis* has four leaves in a whorl, and here again we have the irregular branching of the Junipers.

"The result of these observations is that in a large number of cases the frequency or degree of branching is seen to be associated with declining vigour; that presence of leaves in an opposite pair is favourable to a regularity of branching on even numbers; and that whorls of three or more are associated with irregular branching on odd numbers." Probably the phenomena noted by Mr. Meehan are not so much the result of declining vigour as of alteration in the direction and locality in which the energy is manifested. The long quick-growing extension-shoots have, as their function, the formation of the trunk and principal branches; the multitude of branchlets is adapted to sustain an even greater number of leaves on whose due action the life of the whole tree depends. Vigour, or the amount of work done, may be as great in the one case as in the other, though exerted in a different direction. It is probable that some of the irregularities

mentioned by Mr. Meehan may be associated with deviations from the usual course of the fibro-vascular bundles in the stem*.

It does not, however, fall within the scope of this paper to do more than incidentally allude to the histology of the stem. Goeppert, Schacht, Bertrand, Renault, and others have investigated the subject, and shown how in certain cases the genera may be distinguished by the number and disposition of the areolar punctuations and tracheids as well as by the position of the resin-canals. Dr. Mayr also, in his 'Waldungen von Nord-America,' p. 424, arranges the sections of *Pinus* according to the construction of the wood.

The Male Flowers.

The male flowers of Conifers consist of a number of stamens, each mostly with a filament and an anther or microsporange. These are arranged in various ways at the ends or on the sides of the shoots, so as to resemble the "catkins" of an amentaceous inflorescence. Much controversy has, indeed, arisen as to whether the seeming amenta of these plants are really to be considered as inflorescences composed of a series of axes bearing numerous monandrous, naked flowers, or as single, polyandrous flowers.

Following Linnæus, Griffith considered the aggregate of stamens to constitute a single flower. The reasons assigned by Griffith for this opinion were the absence of bracts or scales intermixed with the individual stamens and the unjointed condition of the filaments. The stamens are serially continuous with the leaves, in spires in the Abietineæ, or in decussate whorls in the Cupressineæ. Monstrous examples also show the passage of the stamens to leaves, as in some species of *Podocarpus* and *Araucaria*, as well as in Abietineæ†.

* Van Tieghem, 'Traité,' p. 737, says that the vascular bundles of *Thuya* form four sympodes which traverse the stem in a wavy or undulated manner. At each node is given off to the left a branch which runs through only one internode before it reaches a leaf. The leaves are thus in alternate pairs; and a transverse section shows six bundles—four cauline and two foliar; a subdivision of one of the foliar bundles would naturally accompany the formation of an additional leaf, as when a dimerous whorl becomes trimerous.

† The now generally adopted view that the aggregate of stamens constitutes one flower was, as above stated, held by Linnæus, who included several genera of Conifers under his class Monadelphia (Polyandria), assigning to the male flowers of *Pinus* a 4-leaved calyx. Griffith, Itin. Notes, p. 376; Mohl, Vermischte

Position of the Flowers.—The male flowers are either distinctly terminal (fig. 15) at the points of the young shoots, as in most of

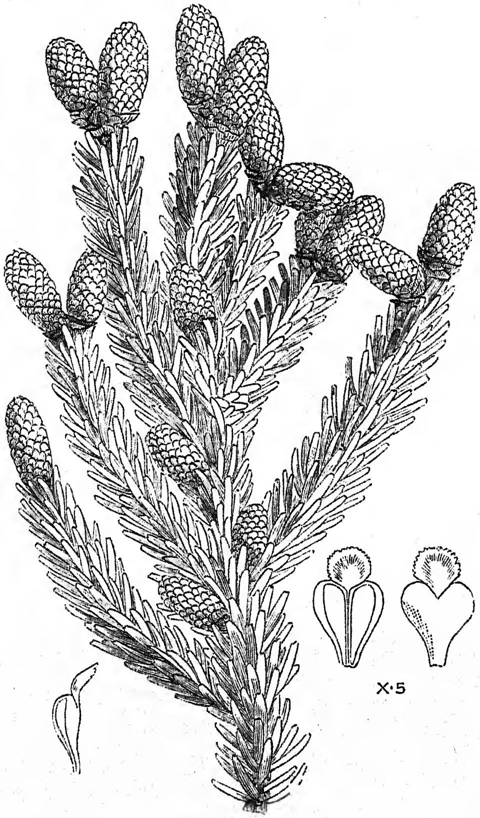


Fig. 15.—Male flowers of *Picea orientalis*, terminal, brilliant carmine; anthers crested.

Schrift. p. 45; Dickson in Trans. Bot. Edinb. vi. (1860), p. 418; Eichler in Flor. Brasil. (Coniferæ), and in 'Bluthendiagramme,' i. p. 59, and in Engler, Pflanzen-Familien Coniferæ; Strasburger, Coniferæ; Engelmann, Revision of *Pinus*, p. 7; Bentham in Bentham and Hooker, Gen. Plant. iii. p. 420; Goebel, Outlines of Classif. and Special Morphol. (1887), p. 323.

The opposite opinion, that the flowers are numerous, naked, monandrous, and arranged in catkins, was held by Zuccarini, Morphology of the Coniferæ, Ray Society, 1846, p. 48; Parlatore in DC. Prodr. xvi. p. 361; Lindley, Vegetable Kingdom, p. 227; Baillon, Dictionnaire de Botanique, ii. p. 181; A. L. de Jussieu, Gen. Plant. ed. Uster, p. 493.

the Cupressineæ, or they are borne in the axils of the leaves (fig. 16) on the sides of the main shoots, sometimes on those of the year (hornotinous), as in the species of *Pinus*, at other times on shoots of the second and third years, as in *Larix*, *Pinus*, *Abies*, &c.

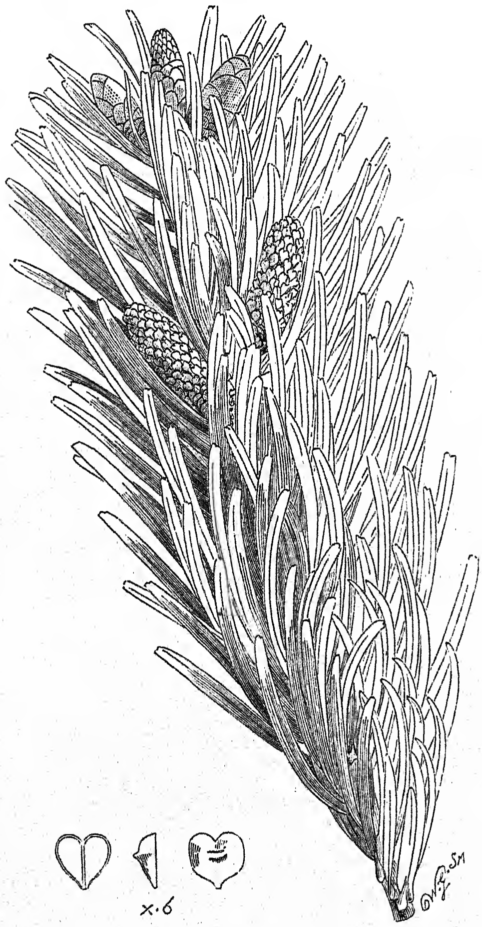


Fig. 16.—Male flowers of *Abies amabilis*, solitary, lateral, yellowish; anthers without a crest, but with a point at the back.

There is sometimes a variation in this respect in different species of the same genus, *e. g.* in *Juniperus*, and where the axillary leaves are abortive or ill-developed it is not possible in all cases to say,

without having traced its course from the beginning, whether the inflorescence be terminal or lateral. For practical purposes, the prolongation of the leaf-shoot beyond the flowers is a mark of the lateral position, as its arrest is an indication of the terminal arrangement. In some cases, as in *Ginkgo* and other Chinese and Japanese forms, the male flowers are stalked, and arranged in umbellate fashion at the ends of short spurs *.

The physiological significance of the position of the male flowers on the shoots of the current year's growth, as in *Pinus*, or on those of former years, as *Larix*, as just referred to, has not been worked out; but it would seem probable that some relation might be traced between this arrangement and the nature of the climate. For instance, *cæteris paribus*, it would seem probable that the newly expanded flowers on the herbaceous shoots would be more likely to suffer from spring frosts and have a less perfect store of previously assimilated nutriment to draw on than in the case of flowers produced on shoots of the second year. The flowers produced on the second and third year's wood would also have the benefit accruing from division of labour, as the herbaceous shoots of the first season's growth would, in such case, be confined to their duty of extending the plant by the lengthening of the branches (extension-shoots).

Number and Arrangement.—In some species the flowers are solitary, or dispersed at intervals, as in *Araucaria* spp., *Agathis* spp., *Torreya*, *Picea*, *Larix*, *Cedrus*, &c.; whilst in others they are aggregated into close heads, as in *Athrotaxis*, *Sequoia*, *Tsuga*, *Sciadopitys*; in long spikes, as in *Abies*, *Picea*, *Pinus*, &c.; or in single umbels or umbellate cymes, as in *Ginkgo*, *Pseudolarix*, *Keteleeria*, *Cunninghamia*, &c.

Sometimes the flowers are sessile or nearly so, as in *Larix*; at other times stalked, as in *Pseudolarix*, *Ginkgo*, some species of *Abies*, &c; and in some species of *Podocarpus* the floral axis is branched.

The following list will suffice to show the most usual arangements:—

Male flowers terminal, spiciform, solitary:—Most Cupressineæ, some species of *Juniperus*, *Taxodium*, *Sequoia*, *Athrotaxis*, *Phyllocladus* (some species), *Dacrydium*, *Phærosphora*, *Microcachrys*,

* For *Pseudolarix*, see Mast. in Journ. Linn. Soc., Bot. vol. xxii. p. 210, tab. x.; and for *Keteleeria*, Pirotta, in Bull. Soc. Hort. Toscan. (1887), p. 274.

Saxe-Gothea, *Podocarpus* (some species), *Araucaria*, *Cedrus*, *Larix*, &c.

Male flowers capitate:—*Taxus*, *Cephalotaxus*.

Male flowers lateral, spiciform, solitary or clustered:—*Abies*, *Pseudotsuga*, *Tsuga*, *Picea*, *Pinus*, *Sciadopitys*, *Cryptomeria*, *Torreya*, *Phyllocladus*, *Saxe-Gothea*, *Dacrydium*, *Araucaria* sp.

Male flowers apparently terminal, umbellate:—*Ginkgo*, *Cunninghamia*, *Pseudolarix*, *Keteleeria*.

Male flowers branched:—Some species of *Podocarpus*, *Tsuga* (sometimes), *Taxodium*.

Perulation and Phyllotaxy.—In some species there is a direct or abrupt transition between the foliage-leaves and the male sporophylls, as in most of the Cupressineæ, *Frenela*, *Microcachrys*, &c. When this happens there is, of course, no break in the sequence of the leaves, the phyllotaxy remains unaltered, foliage-leaves and stamens are alike decussate, and there are no perulæ or bracts at the base of the flower, which in such cases is sessile or not markedly stipitate.

In other species the transition is less abrupt, scale-leaves follow the foliage-leaves, to be succeeded by the true sporophylls. Sometimes organs intermediate between leaves and stamens may be found. The formation of perular scales or bracts is, of course, the result of a temporary arrest of growth. When growth recommences, it generally happens that the axis of the flower lengthens, so that the flower becomes markedly stipitate. At the same time it usually happens that the perulæ and also the stamens are arranged spirally, even though the foliage-leaves may be verticillate: thus in most Cupressineæ leaves and stamens are alike decussate; while in other cases the stamens are spirally disposed even where the leaves are decussate, as in *Athrotaxis*, *Libocedrus*, *Microcachrys*, some species of *Podocarpus*, e. g. *P. dacrydioides*, and *Dacrydium*. Engelmann * says that the number of perular scales, or, as he calls them, involucral bracts (calyx of Linnæus), "varies in the different species of *Pinus* from 3–16; but it is fairly constant in the same species. The two exterior lateral bracts are strongly keeled, like those of the sheath of the leaves, and stouter and mostly shorter than the others; the third is placed on the upper side towards the axis of the inflorescence; the fourth on the lower or dorsal side opposite the supporting bract, and so forth.

* Engelmann, Genus *Pinus*, p. 8,

The innermost ones not rarely exhibit a transition to the anthers, bearing small or incomplete anther-cells on the lower part of their back. In *P. resinosa* and *P. canariensis* I find the involucral bracts articulated in the middle." Engelmann then gives the following numerical table of the bracts: 3–4 in *P. silvestris* and *Pinaster*; 3–6 in *P. densiflora*; 4 in *P. Balfouriana*, *canariensis*, *Greggi*; 4–5 in *P. edulis* and *Parryana*; 4–6 in *P. Pinea* and *P. halepensis*; 4–10 in *P. pyrenaica*; 5–6 in *P. monophylla*; 6 in *P. leiophylla*, *Laricio*, and *contorta*; 6–7 in *P. resinosa*, *montana*, and *Massoniana*; 6–8 in *P. Strobus*, *excelsa*, *Peuke*, *Cembra*, *rigida*, *tuberculata*, *muricata*, *pungens*, and *Banksiana*; 8–10 in *P. monticola*, *flexilis*, *insularis*, *Chihuahuana*, *Thunbergii*, *Laricio*, vars. *pyrenaica* and *austriaca*, *Coulteri* and *inops*; 8–12 in *P. Tæda*; 9–12 in *P. Montezumæ* and *mitis*; 10 in *P. insignis*; 10–12 in *P. ponderosa*; 10–15 in *P. Sabiniana*; 12 in *P. Merkhusii* and *Elliottii*; 12–14 in *P. khasia*, *glabra*, and *australis*; 14–16 in *P. Lambertiana* and *cubensis*.

Eichler* gives the following details as to the phyllotaxy of the stamens in various species:—2/5 in *Cryptomeria japonica*; 3/8 in *Taxus baccata*; 8/21 in *Podocarpus Sellowii*, *Lamberti*, *Larix europæa*; 13/34 in *Picea excelsa*, *P. glauca* [?]; 2/7, 2/9, and in 4–5-merous whorls (2/8, 2/10), *Pinus pumilio*, *P. silvestris*; 2/13, 2/15, *Pinus nigricans*; 2/27–2/31, *Araucaria brasiliana*.

Form, Size, and Colour.—The variations in these respects presented by the male flowers are serviceable for the discrimination of species and varieties even in cases where they are not of great morphological or physiological significance. Thus in the genus *Pinus*, for example, the flowers vary considerably in size; they are short, thin, slender or long and thick, straight or spirally coiled.

In colour they are usually of some shade of yellow, from very pale lemon-yellow to deep orange. In other cases they are of a violet or crimson colour.

As these plants are supposed to be purely anemophilous, it is difficult to explain the reason of the marked conspicuousness of the male flowers, unless it be as an attraction to pollen-eating insects.

The anthers, or male sporangia, of Conifers are borne either on the sides or on the under surface of the staminal leaf or spo-

* Bluthendiagramme, i. p. 60.

rophyll. This leaf consists of a filament expanding above into a connective representing the lamina of an ordinary leaf and which is usually flat, in one plane, with one anther-lobe on each side (fig. 17), or the laminar portion may be more or less expanded at right angles to the stalk, thus forming a peltate expansion as in *Taxus*, or much more developed at the apical end than elsewhere, as in most of the Cupressineæ.

Fig. 17.—Anther of *Sequoia*.

Sometimes the anthers are arranged in a ring around the point where the filament expands into the peltate lamina (*Taxus*), thus resembling the arrangement of the sporangia in *Equisetum* or *Marchantia*. In other cases they are placed at the lower edge of the lamina below the attachment of the stalk or filament, as in Cupressineæ, an arrangement which may be compared to that of *Zamia*.

The number, colour, form, and mode of dehiscence of the anther-lobes vary in different genera and species, as does also the appearance of the connective.

Some of the principal modifications may here be incidentally mentioned.

Number of Pollen-Sacs:—2 in *Pinus*, *Picea*, *Abies*, *Podocarpus*, *Dacrydium*, *Ginkgo*, *Phyllocladus*, *Athrotaxis*, *Sequoia*, *Sciadopitys*; 2–4 in *Cupressineæ*; 3 in *Cephalotaxus*, *Cunninghamia*; 4 in *Torreya*; 5–8 in *Taxus*; 8–15 in *Agathis*; 6–20 in *Araucaria*, &c.

Direction of the Anther-lobes:—(1) Parallel with or mostly continuous with the filament: *Pinus*, *Abies*, *Picea*, *Sequoia*, *Sciadopitys*, *Phyllocladus*, *Agathis*, *Pseudolarix*.—(2) Divergent at the base, often pendulous from the apex of the filament or peltate: *Taxus*, *Ginkgo*, *Tsuga*, *Sciadopitys*, *Cunninghamia*, *Torreya*, *Microcachrys*, *Dacrydium*, *Podocarpus*, *Araucaria*, most of the *Cupressineæ*, *Sequoia*, *Athrotaxis*, *Cryptomeria*, *Taxodium*.

Dehiscence of the Anthers:—(1) Longitudinal: *Pinus*, *Agathis*, *Araucaria*, *Cedrus*, *Larix*, *Pseudolarix*, *Sciadopitys*, *Cunninghamia*, *Sequoia*, *Athrotaxis*, *Cryptomeria*, *Taxodium*, *Callitris*, *Libocedrus*, *Cupressus*, *Juniperus*, *Phyllocladus*, *Cephalotaxus*, *Taxus*.—(2) Transverse: *Abies* (some species), *Podocarpus* spp., *Dacrydium*, *Microcachrys*, *Pseudotsuga*.

The Connective.—The variations presented by the connective are also of value for classificatory purposes. Physiologically the con-

nective seems, in many cases, to serve as a protection against wet or cold and perhaps against the intrusion of undesirable insects. On the other hand, when the flowers are expanded the open, brightly-coloured connective may serve as an indication of the presence of food to pollen-eating insects, even although they do not take part in the fertilization of the flower.

The following will show the principal variations of which the connective is the subject:—

Connective peltate:—*Taxus*, &c.

Connective prolonged, ending in a semi-peltate expansion:—*Agathis*, *Araucaria*, *Pinus*, *Cedrus*, *Larix*, *Picea*, *Abies* spp., *Sciadopitys*, *Cunninghamia*, *Sequoia*, *Athrotaxis*, *Cryptomeria*, *Taxodium*, *Callitris*, and *Cupressineæ* generally, *Microcachrys*, *Podocarpus*, *Dacrydium*, *Phyllocladus*, *Cephalotaxus*.

Connective scarcely, if at all, prolonged, or ending in a small knob or linear process:—*Ginkgo*, some species of *Abies* (e. g. *grandis*, *Pinsapo*), *Torreya*, *Tsuga*, *Sciadopitys*, *Pseudotsuga*, some species of *Pinus* (e. g. *Strobus*).

When prolonged the direction of the prolongation is usually more or less at an angle with the direction of the anther-lobes, and the arrangement is such that in the unexpanded flower the connective of one stamen overlaps the anther next above it, but in *Saxe-Gothea*, according to the illustration (Lindl. Veg. Kingdom, p. 229 *b*), the connective is bent directly downwards and thus covers over its own anther.

Pollen-grains.—The differences in the form of the pollen-grains have been made to serve as points of distinction between the Cupressineæ and the Abietineæ, being globular in the former and provided with wing-like extensions in the other *. These distinctions, however, cannot be considered as absolute, for *Pseudotsuga Douglasii*, which is certainly Abietineous, has the globular pollen of the Cupressineæ.

The microscopical appearances of the pollen of various species and the formation of a male prothallium by subdivision of the pollen-cell may here be passed over with mere incidental mention and a reference to the works of Strasburger (Conif. u. Gnetac.). Nor does it fall within the scope of this paper to do more than make passing allusion to the relationship existing between the

* Brown and Bennett, Plant. Javæ Rarior. p. 37.

microsporangium of the Vascular Cryptogams and the anthers of Conifers *.

Certain differences may, however, be indicated. Thus in *Lycopodium* and *Isoëtes* the sporangia are borne at the base of the upper surface of the leaf, as also in *Lepidodendron*; in *Selaginella* they issue from the stem above the leaf (Goebel); whilst in Conifers and Cycads the anthers occupy the lower surface or lower edge of the staminal phyllome. Goebel even points to an analogy between a special growth of tissue on the under surface of the staminal leaf of *Cupressus, Thuya*, and some species of *Juniperus*, and the indusium of Ferns.

Relation of the Stamens to the Leaves.—From what has been already stated it is obvious that the stamens are strictly homologous with the foliage-leaves, their position and arrangement are the same; and although the structure is modified by the formation of sporangia, yet intermediate conditions between the leaves and the stamens are met with as monstrosities, and similar transitions of a more gradual character are to be met with: thus, in *Frenela robusta* the uppermost leaves pass insensibly into stamens bearing anthers at their sides and base, and these into true peltate stamens with the anthers on the under surface. A similar sequence is obvious in many species of *Juniperus, Cupressus, Larix*, &c. In *Pinus* the stamens are serially continuous with the primary leaves and not with the secondary leaves. Further details as to the homology of the stamens will be found in the section treating of the malformations of the flower.

The flowers of *Pinus* are borne on the shoot of the year and originate in the axils of spirally disposed perulæ just as the fascicles of leaves do, so that one group of stamens has the same relative position as one fascicle of leaves. The leaves of the male flower themselves bear the anthers or microsporangia, while in the female flower, as will be seen hereafter, the sporangia are borne, not on the floral leaves (bracts), but on "a something" which originates within their axils.

In the Larch the bud-scales are spirally imbricated around the base of a column bearing numerous stamens. These male flowers are placed on the second year's wood and correspond in position

* Consult Hofmeister, Higher Cryptogamia, ed. Currey (1862), p. 401, &c. Goebel, "Entwick. d. Sporangien," in Bot. Zeit. 1881; Outlines of Classification, &c. ed. Balfour, 1887, p. 325.

with the "spurs" bearing the tufts of ordinary leaves, and are arranged on the $\frac{2}{5}$ plan *.

THE FEMALE FLOWERS.

The essential portions of the female flower consist of one or more ovules which are erect or inverted and composed of one coat investing a central nucellus, and sometimes covered from below upwards by a fleshy tubular or annular aril which grows out from the axis, after the formation of the other parts and during the course of their development (*Taxus* &c.). What is here called an ovule is considered by Baillon, Dickson, A. Murray, Parlatore, and others to be an ovary destitute of style or stigma. The question of angio- or of gymnospermy is, however, one which I do not propose to discuss in this present paper. Outside the ovule is a scale, the seed- or cone-scale, and outside that again another scale, the bract. Frequently the two scales just mentioned are more or less completely combined so as to give the appearance of a single organ. The discussion as to the morphological significance of these several parts may be appropriately deferred until after a general review has been taken of their appearances in different genera.

The simplest cases occur in the Taxeæ and Podocarpeæ, as for instance in *Pherosphæra*, in which the bract and seed-scale appear to be one and the same, and are flat, somewhat fleshy, and arranged spirally in spikes at the ends of the branches. Each fertile branch here subtends a single erect ovule with no arillus.

In *Saxe-Gothea* the structure is equally simple. The flat leaves pass gradually into spirally arranged perulæ at regular distances apart, for the length of an inch or so below the cone. Above, these perulæ pass gradually into loosely and spirally imbricated, ovate-lanceolate, fleshy seed-scales with a cavity near the base of the inner surface, from the upper part of which hangs the ovule. A single coat invests the nucellus without any trace of arillus.

The female flowers of *Dacrydium Franklinii* are almost equally simple, but are arillate. The seed-scales are arranged in spikes and each scale bears an erect ovule invested by a tubular arillus.

In *Taxus* the cone consists of a number of spirally imbricated scales arranged on the $\frac{2}{5}$ plan, and all of which, except one, are

* See Meehan in Proc. Acad. Nat. Sc. Philadelphia, July 11, 1871.

sterile. The macrosporange or ovule is erect and borne in the axil of a bract placed so close to the apex of a shoot as to appear terminal, particularly as the apex of the shoot is arrested in its development. Eventually the ovule becomes invested by a tubular sheath which grows from below upwards and develops into a fleshy aril, in whose cup all but the apex of the ripe seed is concealed.

Hooker * considers this aril to be the outer coat or primine of the ovule, an opinion which the internal anatomy hardly suffices to confirm. The mode of development of the ovule, or, as Baillon considers it, the ovary, of *Taxus*, as well as of *Phyllocladus* and *Torreya*, has been studied by that botanist †.

The female flowers of *Torreya* consist of an ovule the testa of which becomes fleshy, and at the base of which is sometimes to be seen a short imperfectly developed aril, though in the ripe seed it is not to be seen.

In *Ginkgo* the flower consists of an elongated stalk which bears on either side just beneath the apex a straight ovule or macrosporangium. The outer covering or test is surrounded by an imperfectly developed aril which remains dry, while the test itself becomes fleshy. According to Van Tieghem the vascular system of the peduncle of this plant has its xylem directed outwards and downwards ‡.

The resemblance of the flowers of the two last-named genera to those of *Cycas* is noteworthy.

In *Cephalotaxus* the female flowers are clustered in bracteate heads at the ends of axillary pedicels. The bracts are arranged in decussate pairs, each bract subtending two flowers. The ovule consists of an erect nucellus the coat of which, as well as the base of the bract, becomes fleshy in course of development. Usually only one of the two ovules in the axil of each bract develops. By Bentham this genus is included among the Taxodieæ, but its ultimately succulent bract and aril seem to indicate a nearer relationship to the Taxeæ. An approximation to *Cycas* is also evident; but this is even more marked in the following genus.

Phyllocladus.—In this genus the female flowers are borne either

* J. D. Hooker in Trans. Linn. Soc. vol. xxii. (1859), p. 138.

† Baillon, Recherches Organogèniques sur la fleur femelle des Conifères, p. 4 (1860).

‡ Van Tieghem, Anat. Comp. de la fleur femelle &c. des Conifères, &c., &c. pl. xv. figs. 58–62; Ann. Sc. Nat. sér. 5, t. x. (1869).

singly, or in clusters on the side of a branched phylloclade which has some external resemblance to the ovuliferous scale of *Cycas*, which latter, however, is foliar. The phylloclade, being partly fertile, partly sterile, suggests a resemblance to a similar condition in *Osmunda*. Each flower of *Phyllocladus* is axillary to a bract which ultimately becomes fleshy. The flower itself consists of an erect nucellus surrounded by an ovular coat which ultimately becomes hard and bony, and which is itself partially invested at the base by a tubular fleshy aril.

In the genus *Microcachrys* * the decussate leaves pass abruptly into the bracts or seed-scales, but with a change from a decussate to a spiral arrangement. The fruit-scales are ovoid and boat-shaped, becoming ultimately succulent, and each one bears a single inverted pendulous ovule from the incurved upper margin. The seed is partially invested at the base by a tubular, fleshy aril. In the position of the solitary ovule there is a resemblance to *Saxe-Gothea* and to *Agathis*.

Podocarpus is remarkable for the fleshy development of the peduncle and of the bracts that spring from and which are congenitally united with it. The flowers are solitary or in pairs in the axil of one of the uppermost bracts. The ovule is inverted, its funiculus being adherent to the fleshy bract. The structure, according to Van Tieghem (*loc. cit.* t. 15. figs. 79–86), shows that whilst the bracts have the xylem and phloem arranged as in leaves, $\frac{x}{p}$, in the raphe of the ovule the arrangement is reversed, $\frac{p}{x}$, as is generally the case in the fruit-scales of Conifers.

In the Cupressineæ and the other tribes which follow, there is never any fleshy aril, and only in one genus, *Juniperus*, do the seed-scales become fleshy. Moreover, the fruit-scale, which externally appears in many of the genera to be a single organ, in others shows traces of a compound nature, a complexity indeed which is revealed in all the genera the microscopic anatomy of which has been studied. The scales of the cone are arranged in decussating whorls and in continuous sequence with the ordinary leaves. Sometimes the transition is abrupt without intermediate forms; at other times there is a gradual passage from leaf to fruit-scale, some of the phyllomes having more of the characteristics of leaves, others of fruit-scales.

* J. D. Hooker, Flora Tasmaniæ, tab. 100 A.

The simplest illustration is that of *Diselma*, now referred to *Fitzroya*, and in which the erect ovules are borne in pairs in the axil of each leaf. In a few genera, e. g. *Callitris*, spp. var., and *Actinostrobus*, the fruit-scales are verticillate and valvate. The whole cone is to be considered as a single flower, inasmuch as the separate scales are direct productions from the axis, without perianthial covering and destitute of articulation.

The ripe seed-scales are woody in most of the genera, but ultimately succulent in *Juniperus*. In some cases a longitudinal section shows that the cone-scale is approximately of the same thickness throughout, or at least without any sudden marked change in thickness throughout its length, e. g. *Callitris*, *Thuya*, and *Biota*. In others, as in *Fitzroya patagonica*, *Libocedrus*, *Thuya* sect. *Chamæcyparis*, *Thuyopsis dolabrata*, the base of the scale is thicker than the apex; while in *Thuyopsis borealis*, *Thuya* (*Retinospora*) *obtusa*, and *Cupressus* the apex (exclusive of any terminal mucro) is thickest.

Still more noticeable is the circumstance that while in some instances, *Callitris*, *Thuya*, *Fitzroya*, *Cupressus*, *Juniperus*, the fruit-scale is apparently single and undivided, in others, though single below, it is divided above into two superposed laminæ often of a different shape, as in *Libocedrus tetragona* and *Retinospora leptoclada*, a form of *Chamæcyparis sphæroidea*.

Anatomical Structure.—In the scale of *Actinostrobus*, passing from without inwards, we have a brown epidermis encircling a mass of parenchyma containing chlorophyll and traversed by two or more resin-canals. Towards the centre, or rather nearer to the ventral side, is a double row of fibro-vascular bundles. In the lower or outer row the phloem is external and the xylem internal, while in the upper row the phloem is above, the xylem below, an arrangement similar to that in the Abietineæ. *Cupressus* has a similar structure, and indeed the other genera of the suborder, as shown by Van Tieghem *.

The development of the ovules has been studied by Baillon, who, as before noted, considers them to be ovaries developed in the axil of fertile bracts †.

Nature of the Fruit-scale.—In some of the genera, as we have

* Van Tieghem, Traité de Botanique, p. 1327; Anatomie de la fleur des Gymnospermes, p. 275.

† Baillon, Recherches Organ. sur la fleur femelle des Conifères, &c. p. 8.

seen, the scale at maturity appears to be single; in other cases there is an appearance which might be supposed to indicate the concrescence of two organs (*Libocedrus*).

Griffith *, who was not aware of the internal structure of the scales, considered the scales of the cone of *Cupressus* as the equivalent representatives of the membranous scales [bracts] of *Pinus*, hence he concluded that they were not carpellary leaves but bracts. This view accords with the uninterrupted sequence of the foliage-leaves and cone-scales, but leaves a difficulty as to the origin of the ovules.

Eichler † once held similar views as to the single and foliar nature of the cone-scales in this group.

Kramer ‡ considers the fruit-scales of Cupressineæ as single independent leaf-organs which in process of time develop outgrowths from their upper surface and from which the ovules spring. These outgrowths are therefore regarded as of a placentary nature.

Van Tieghem, on the other hand, states, from a consideration of the anatomical structure described in a previous paragraph, that the scale is double, consisting of the bract and of the ovuliferous scale, which he regards, as in the Abietineæ, as the first leaf of an axillary bud producing ovules on its dorsal surface and in union by a sheath of parenchyma with the bract §.

Arcangeli ||, agreeing with Van Tieghem as to the anatomical facts, gives another interpretation of their significance. He considers that the two fibro-vascular bundles form part of one and the same organ, *i. e.* a more or less modified branch bearing female flowers and occasionally a simple leaf.

The tribe Taxodieæ, as defined by Bentham and Hooker, is an artificial group, scarcely, if at all, to be distinguished from the Araucarieæ except by the erect ovules, but in *Athrotaxis* the ovules are ultimately pendulous. The fruit-scales are arranged

* Griffith, Itin. Notes, p. 376.

† Excurs. Morphol., in Flora Brasil. fasc. xxxiv. 1863, col. 435.

‡ Kramer, "Beiträge z. Kenntn. d. Entwick. Geschichte u. d. Anat. Baues d. Fruchtblätter d. Cupressineen u. d. Placenten d. Abietineen," Flora, November 1885, p. 567, tab. 9.

§ Van Tieghem, Anatomie de la fleur des Gymnospermes, p. 275.

|| Arcangeli, "Sur la Structure de la fleur femelle des Conifères, &c.," Congrès Internat. Botan. Paris, 1878 (published in 1880), p. 35.

spirally, not in verticils as in Cupressineæ. The bracts are in continuous spiral sequence with the leaves. The fruit-scales of *Cryptomeria* are closely united for three fourths of their length with the bract, and are dilated at the end into a roundish, crenately-lobed extremity projecting beyond the bract as in *Chamæcyparis* among Cupressineæ. It is noteworthy, that while in the male flowers of *Cryptomeria* the transition between the leaves and the stamens is abrupt, in the females it is gradual and with some of the phyllomes imperfect or intermediate in character between true leaves and perfect stamens.

In *Taxodium*, *Sequoia*, and *Athrotaxis* * the construction of the female flower is essentially the same as in *Cryptomeria*, traces of the bract being sometimes quite obliterated in the ripe cone, e. g. *Sequoia sempervirens*.

The Araucarieæ are scarcely separable from the Taxodieæ except in the position of the ovule, inverted in Araucarieæ, erect in Taxodieæ. Eichler, in Engler's 'Die natürlichen Familien,' has, by oversight, included the genus *Cunninghamia* among the last-mentioned series, but by reason of its inverted ovules it belongs to the Araucarieæ.

In the genus *Cunninghamia* the bracts are arranged spirally, being continuous with the leaves; the seed-scale is relatively small and concealed by the bract. In most Conifers the seed-scales form the most conspicuous part, but in *Cunninghamia* the bracts form by far the largest proportion of the cone. An examination of the inner surface of the bract in the ripe cone shows the upper free portion of the seed-scale in the form of a thin membranous crest projecting a short distance above the inverted ovules, fig. 18, 8.

In an imperfectly developed and unfertilized cone the following appearances were presented:—The lowest bracts were quite like the leaves, but thickened at the base (fig. 18, 1 and 2). Next above these were bracts bearing a small cellular outgrowt of a reddish colour just above the short stalk of the bract. Succeeding scales (fig. 18, 3, 4, 5) had 2–5 similar cushion-like processes, which, as has been said, are purely cellular. It is difficult to be

* The resemblance of the cone of *Athrotaxis* to that of *Echinostrobus* from the Oolite of Solenhofen is noteworthy; see Renault, Cours de Bot. Foss. tab. 12. fig. 14. *Sequoia* is, as is well known, represented in the Miocene, *loc. cit.* tab. 13.

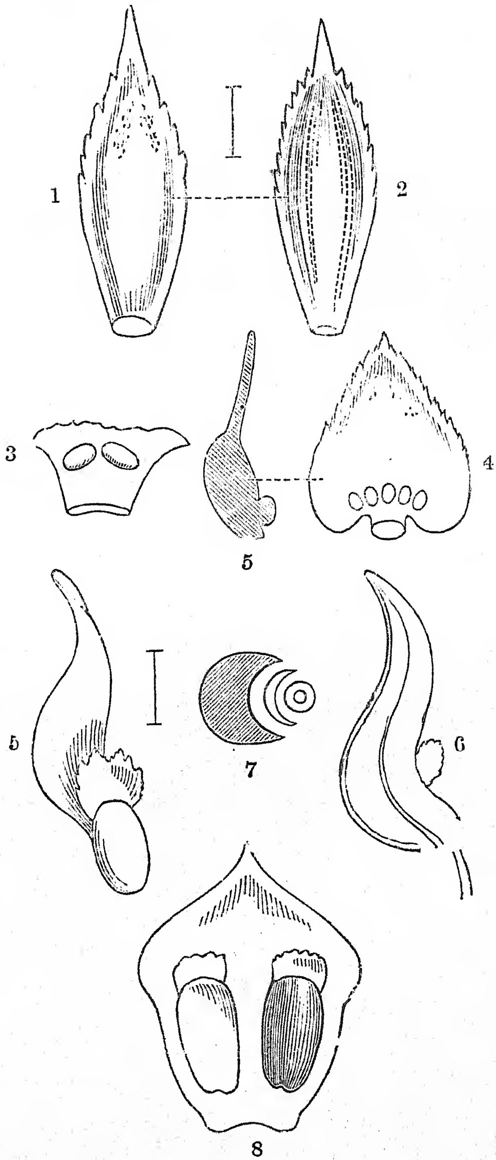


Fig. 18.—*Cunninghamia sinensis.* Scales &c., with sections. (See text.)

certain whether these cellular outgrowths apparently proceeding from the bract are rudiments of the fruit-scale or of the ovules. In the ripened cone the fertilized seeds are seen to depend from a transverse membranous outgrowth (fig. 18, 5, 6, 7, 8) projecting from the inner surface of the bract about its centre, and which calls to mind the ligula above the macrosporangium in *Isoëtes*.

Andrew Murray ('The Pines and Firs of Japan' (1863), p. 120), after pointing out that in this genus the bract takes the larger share in building up of the cone, and that it has a "peduncle" (petiole rather) or foot-stalk, continues:—"The true scale is to be sought inside the bract; near the base a transverse ridge will be seen just above the seeds, which, on examination, will be found to be the scale adherent to, but outgrown by, the bract. . . . . The foot-stalk of the bract appears to belong truly to the bract and not to the real scale, which seems to *spring from the bract* after it has passed the foot-stalk."

Anatomy of the Bract.—A transverse section through the base of the bract of *Cunninghamia* shows, going from without inwards, an epidermis with a tuft of simple hairs, then a layer of hypoderm encircling the ground-tissue of closely-packed ovoid cells. Five resin-canals, each surrounded by sclerous or strengthening-cells, traverse the ground-tissue as well as a few scattered libriform cells. Beyond the centre of the bract is a layer or layers of transversely elongated cells (transfusion-tissue of Mohl). Through this pass two fibro-vascular bundles widely separate from each other, but with no marked endoderm surrounding them. The phloem is directed towards the outer, the xylem towards the inner surface. More cellular tissue follows, then hypoderm, and finally epiderm. Thus the structure is like that of foliar organs in general, though differing in minor detail from that of the leaves of this plant, which have very well marked palisade-cells. The specimens examined by myself were imperfect, as they were taken from unfertilized cones, showed no trace of the fruit-scale proper, and therefore the outgrowths from the bracts were purely cellular, still they were decidedly outgrowths from the bract and not from the axis. Van Tieghem* describes and figures a double fibro-vascular system in the fruit-scales, and in the uppermost part of which the phloem and xylem occupy a position the reverse of that in

* Van Tieghem, Anatomie de la fleur des Gymnospermes, p. 301, tab. 15. figs. 77, 78.

the lower portion, which latter represents therefore a leaf or bract within the same cellular sheath as the fruit-scale proper.

In the genus *Agathis* (syn. *Dammara*) the condition of things is much as it is in *Cunninghamia*; the bracts are in spiral sequence with the leaves, a few intermediate structures being found at the base of the cone. The fruit-scale is not visible externally, the seeds springing, or appearing to spring, direct from the inner surface of the bract. The seed of *Agathis* is provided with one wing (or sometimes two), and this wing, according to Dickson, is on the right side if the direction of the bracts be dextrorse, to the left if the cone-scales be sinistrorse. This observer has traced the development of the inverted ovule of *Dammara* from the base of the bract, so that in *Agathis* we have the same condition as in *Callitris*. Dickson * considers that there is concrescence between the bract and the peduncle of the flower (ovule). In support of this he shows a double vascular bundle, one division going to the bract, the other to the ovule, but this latter may belong to the seed-scale and be, in fact, its only representative. Eichler, however, figures the bundle which proceeds to the ovule as springing from that proceeding to the bract. Van Tieghem † figures a double vascular system in the bracts of *Agathis* (*Dammara*), the upper series belonging to the seed being completely concealed within the same epiderm and parenchyma as that which surrounds the vascular system of the bracts.

In *Araucaria* the bracts are continuous with the leaves, as in *Agathis*, and are congenitally adherent to, or inseparate from, the fruit-scale, which latter, in the mature cone, largely exceeds the bract, just the opposite of what happens in *Agathis*. Brongniart and Gris ‡ review the different opinions that have been held as to the simple or compound nature of the scale, and sum up by expressing their assent to the views put forth by Dickson and Van Tieghem as to its double nature, as revealed by the arrangement of the vascular bundles, which is essentially that of other Coniferæ, although the bundles for the bract and for the seed-scale remain invested by one undivided sheath of cellular tissue.

In *Sciadopitys* the bracts are in continuous sequence with the

* Dickson, Bot. Soc. Edinb. July 11, 1861.

† Van Tieghem, Anatomie de la fleur des Gymnospermes, tab. 15. figs. 74–76.

‡ Bull. Soc. Bot. France, vol. xviii. (1871), p. 135; Dickson, Bot. Soc. Edinb. 1861; Van Tieghem, *l. c.* p. 277.

cataphyllary leaves and are arranged spirally. The young unfertilized cones show the bract to be lanceolate, thick and fleshy at the base, thin above the middle; the thick portion is persistent throughout, but the thinner portion gradually shrivels and becomes smaller in advancing from the base of the cone upwards: the lowermost bracts have no fruit-scale within them; those immediately above the base of the cone produce a transverse line of white, many-celled hairs about the middle of the inner surface and which may be compared to the membranous outgrowth in *Cunninghamia*. Above these are other bracts having in their *axils* fleshy semilunar scales, less than half the size of the bracts. At this stage the fruit-scales are entirely cellular and consist of cells arranged in radiating lines. About the middle of the inner surface of the bracts next succeeding, a transverse groove may be seen. In the adjacent scale one ovule is observed, in the next three, in the next 5, 7, and 9 respectively. The number of the ovules and their position is not the same in all the bracts, but if there be only one ovule that one is always in the centre.

Structure of the Fruit-scale.—If transverse and vertical sections be made of the base of the scale of *Sciadopitys* at this stage, bundles of spiral vessels will be seen corresponding in number to the number of ovules, so that the vessels do not appear till the ovules are about to be, or are already, formed. In the bracts of the upper part of the cone the phenomena are the same, but in inverse order, the ovules disappear gradually from the axils of successive bracts, the vessels are no longer seen, and the fruit-scale once more becomes wholly cellular. In the mature cone the fruit-scale largely surpasses the bract in size, and is confluent with it for nearly its entire length. The arrangement of the xylem and phloem in the bract is the same as in a leaf, and corresponds to that in the true leaves of this species; but in the ripe seed-scale the position is reversed, as in the needles or cladodes (see *ante*, pp. 253, 276), and as in the fruit-scale throughout all the genera of the order.

In the Abietineæ the cones are placed on the ends of lateral shoots, and usually show an abrupt transition between the leaves and the perular scales enveloping the female flower, whilst these scales, in their turn, are serially continuous with the bracts. The nature of the fruit-scale in this group has received a larger share

of attention from morphologists and anatomists than has, till recently at any rate, been bestowed upon the other groups. Nevertheless, it will be found, on comparison, that the structure of the cone in this group presents no essential differences from that of other groups excepting the Taxaceæ and Podocarpeæ. The bract is generally conspicuously separate from the seed-scale in the young condition. Sometimes it remains very prominent in the adult state, as in *Pseudotsuga Douglasii*, *Abies bracteata*, *A. nobilis*, &c.; whilst in others it is much smaller than the seed-scale and concealed by it, as in the ripe cones of *Pinus*, or even disappears entirely. In the other genera of this tribe, *Cedrus*, *Picea*, *Tsuga*, *Pseudotsuga*, *Abies*, *Larix*, *Pseudolarix*, the bracts are never entirely concrescent with the scale, as in *Cupressus*, but always more or less separate from the fruit-scale, even in those cases where the latter greatly preponderates. In *Pinus* the cones do not mature till the second year after their formation; whilst in other genera maturation takes place during the first season. The cones in this genus are usually lateral; but an appearance of a terminal position results from the young cone growing faster than the terminal bud, and assuming an erect position while the bud is temporarily turned on one side. Usually after a time the cone is deflexed, and the terminal shoot assumes its proper direction; but in some cases, as in *Pinus Lemoniana** and *P. cubensis* var. *tertrocarpa*, the bud is arrested in its development and the cone remains terminal. Minor differences, available for the discrimination of species, exist, as has been already alluded to.

Development of the Scales.—In the young cone of *Pinus uncinata* the bracts are serially continuous with the perulæ or brown bud-scales. These get smaller and smaller till they become mere membranous rims from whose axil (or apparently so) spring the fruit-scales, each provided with its hook-like termination. In the mature cone in this, as in all other species of *Pinus*, the fruit-scale forms the larger portion of the cone-scale. The bract is thus formed before the fruit-scale; but the latter speedily overtakes it in course of development. At first the bract and the seed-scale are distinct; but by intercalary growth at the base there appears to be formed a little stalk bearing the

* Sir C. Lemon in Trans. Hort. Soc. vol. i. p. 512, t. 20; Murray in 'Pinetum Britannicum,' fasc. v.

two laminæ (bract and seed-scale). The course of development in *Pinus Strobus* is the same. Baillon* gives a similar account of the development in *Pinus recurva*, as does Oersted† of that of *P. pumilio*; but what he speaks of as the median lobe of the axillary scale, and which, he says, is developed subsequently to the other part of the scale, appears to be the true apex of the scale, which is terminated by a mucro and dilates laterally into the umbo. The thickened end or apophysis of the cone-scales is peculiar to some sections of the genus *Pinus* and is an after-development. At first, as in *P. Laricio*, the scale is nearly flat, as it remains in *P. Strobus*, *P. Cembra*, &c.; but as growth goes on, the activity of growth is most manifested on the under or outer surface, so that the scale becomes unsymmetrical and thicker below the (originally) central umbo than above it. In *Pinus Coulteri* the scales retain their primitive equality of proportion, and terminate in a central pyramidal point.

Andrew Murray regarded this umbo and mucro as the representative of a petal! The same author also suggested, as an alternative hypothesis, that the bract was the homologue of the petal, the fruit-scale of the disc; while the wing and test of the ovule or seed were regarded by him as pericarp‡.

Anatomical Structure.—The anatomy of the bract and seed-scale in the Abietineæ is essentially the same as in the other sub-orders, the vascular cords of the bract having always the phloem below, the xylem above; while in the fruit-scale the relative position is reversed, but occasionally, as in *Pseudolarix Kaempferi*, the bracts retain for a longer or shorter period a purely cellular condition, in which no differentiation into xylem and phloem is observable. In this plant the bract and the fruit-scale have a common cellular basis, and the vascular cords pass direct from the axis into the fruit-scale, leaving the bract, at any rate at first, wholly cellular. The essential structure of the fruit-scale, as in all other Conifers, is the same as in the needles of *Sciadopitys* or the cladodes of *Ruscus.* In the bract there is generally a single fibro-vascular bundle, whilst in the fruit-scale there are several in one plane.

The central axis or core of the cone to which the fruit-scales

* Baillon, Recherches Organogèniques, 1860, t. 1.

† Oersted, Bidrag til Naaletrærnes Morphologi (1864), tab. 2. fig. 35.

‡ A. Murray in Gard. Chron. (1866), pp. 8, 852.

either remain firmly attached, or from which, as in the Silver Firs (*Abies*), they become early detached to liberate the seed, presents always the structure of an axis with a central pith surrounded by spiral vessels, a hard woody centre of variable thickness and consistence traversed by medullary rays, and an outer cortex traversed by resin-canals.

Malformations of the Flower.

Only a few of these need here be noticed. The plant figured by Trautvetter* as *Thuiæcarpus juniperinus* is interesting as affording an instance of permanent arrest of development. It is in fact a Juniper in which the fruit-scales, instead of becoming confluent and succulent remain free nearly to the base, and do not assume a succulent character. Like *Retinospora*, it supplies an illustration of a genus founded on characters of a temporary or accidental character. The ordinarily diœcious species, such as *Araucaria imbricata*, sometimes produce flowers of both sexes on the same tree†. Carrière figures and describes a similar occurrence in *Cephalotaxus Fortunei*‡; while in the Yew the monœcious condition is not very uncommon. A gradual transition from the leaves to the stamens or sporophylls is also occasionally met with, especially in prolified flowers of *Larix* and other genera §. Braun notes that although female plants only of *Taxus tardiva* are known in gardens, yet seeds are produced in abundance ‖, probably because the flowers are fertilized by the pollen of *Taxus baccata*. But the most important malformations to be considered, for our present purpose, are certain monstrosities of the cones, which may be comprised under two heads:—(1) Androgynous cones, and (2) Proliferous cones.

Androgynous Cones.—Many instances of this peculiarity are

* Trautvetter, Plantarum Imagines (1844), p. 11, t. 6.

† Masters in Gard. Chron. (1873), p. 291, c. ic.

‡ Carrière in Revue Horticole (1878), p. 117.

§ Schleiden, Principles, ed. Lankester, 1849, p. 229. A. Braun, "Ueber eine Missbildung von *Podocarpus chinensis*," in Monatsb. k. Akad. d. Wissensch. Berlin, October 1869 (*Podocarpus*). (See also Hook. Bot. Mag. t. 4655; Oersted in Vidensk. Meddelels. p. 83.)

‖ Braun in Sitzungsb. bot. Verein. Brandenburg, June 1874, p. 744, *adnot.*

upon record *. One of the most remarkable is that of *Cupressus Lawsoniana*, sent me by Mr. George Syme, a gentleman whose knowledge of living Conifers and their structure is of an extensive character. This specimen was alluded to in my paper on the Morphology of the Primulaceæ. In it the lower scales of the male flower, which were serially continuous with the leaves, bore anthers; while the upper scales (bracts) of the same flower, also serially continuous with the leaves, bore ovules. One scale (see fig. 19) even bore an anther on the outer and an ovule on the inner or upper surface of its basal portion†. It will be remem-

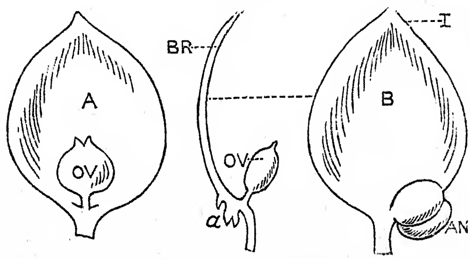


Fig. 19.—Scale of *Cupressus Lawsoniana*, bearing an anther on the outer and an ovule on the inner surface. Magn. 5 diam.

bered that the fruit-scale, such as is met with in the Abietineæ, more or less conspicuously, as distinct from the bract, is not apparent *externally* in the Cupressineæ, though the internal structure indicates, in all the genera yet examined, the presence of a double vascular system, one belonging to the bract, the other to the fruit-scale, as already frequently mentioned.

In the androgynous specimen now referred to some of the

* Mohl, 1837 (repub. in Vermisch. Schrift. p. 45, 1845).
Meyen in Wiegmann's Archiv (1838), p. 155.
Schleiden, Principles (1849), p. 229.
A. Braun, Das Individuum (1853), p. 65.
Dickson in Bot. Soc. Edinb., July 1860.
Caspary, De Abietin. flor. fem. Struct. Morph. (1861).
Cramer, Bildungsabweich. (1864), p. 4, t. v. ff. 13–17.
Parlatore in Ann. Sc. Nat. (1865), sér. 4, t. xvi. p. 215, t. 13 *a*.
Oersted in Vidensk. Meddelelser (1868), p. 83.
Sperk, "Androgynous Cone of *Larix europæa*," in Mém. Acad. Imp. Sc. St. Pétersb. t. xiii. (1869), p. 53, t. 1.
Masters in Gard. Chron. June 30 (1883).

† Masters in Trans. Linn. Soc. ser. 2, vol. i. (1877), t. 41. figs. 9–11.

uppermost scales were thickened at the base, the thickened portion bearing 2–5 erect ovules; but in other instances this thickened portion was wanting, and the ovule was borne at the end of a little stalk in the axil of the bract, or springing from its base. This was the case with the one scale just mentioned, which bore a single anther-lobe on its dorsal surface and a stalked erect ovule from the base of its inner surface without any trace of the fruit-scale, unless the minute stalk supporting the ovule be regarded as representing it. Unfortunately the minute anatomy and disposition of the vascular system was not examined; but it is quite certain that the same scale produced anther and stalk supporting the ovule, and that this scale was continuous with the leaves. An interesting comparison may be instituted between this case and the structure of *Cunninghamia* and of *Sciadopitys* above referred to.

In the instance recorded by Oersted the bracts of the female cone of *Picea nigra* passed gradually into stamens, so that the cone, which was of the ordinary character in its upper portion, passed below into the condition of a male flower. In the axils of some of these staminoid bracts what Oersted called "carpels" were developed, consisting of two squamules of varying form, whilst in the axils of the upper bracts the two squamules had coalesced so as to form a large scale notched at the top, but similar to a carpel. The same author described a cone of *Picea alba* normal in character at the base, above which the bracts gradually increased in size, while the "carpels," *i. e.* the fruit-scales, diminished in size.

In a male flower of *Pinus rigida* examined by myself in 1876 the lower portion was normal, consisting of stamens of the ordinary character, but in the middle these were replaced by flat scales. Some of these latter were sterile, while others had in the axils rudimentary fruit-scales, and others again perfect fruit-scales with inverted ovules.

In *Pinus Thunbergii* I have met with similar changes, the base of the female cone occupied with stamens, continuous below with bud-scales and passing above into bracts with a fruit-scale on the inner surface (fig. 20, p. 314).

A flower of the common Larch (*Larix europæa*) sent me by Prof. Oliver showed the usual perular scales at the base investing the staminal column, the stamens were more or less phyllodic or bract-like and occupied the lower half of the staminal column,

the upper portion bearing numerous bracts, the more perfect of which had a central apical lobe prolonged into a long tube or acumen and two smaller side-lobes. Within and at the base of

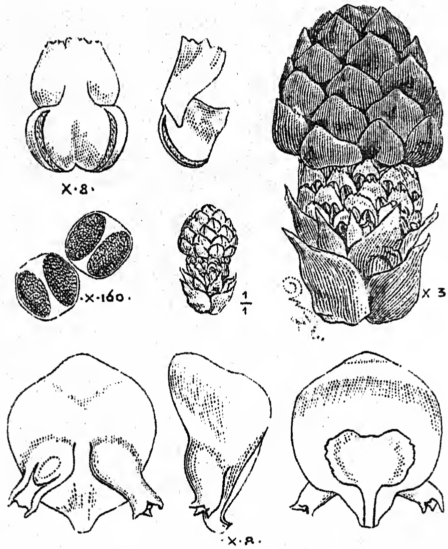


Fig. 20.—Bisexual cones of *Pinus Thunbergii*; with details of structure and pollen-grains.

these bracts was a small pedicled fruit-scale of transversely oblong or reniform shape, very much smaller than the bract in every instance, but with rudiments of two inverted ovules. On making sections in various directions it seemed, in this case, as if the fruit-scale, though produced in the axil of the bract, was not an enation from it, but an outgrowth from the axis above it, it being mostly quite free from the base of the bract, whilst its vascular system proceeded direct from the axis.

Proliferous Cones.—Adverting now to proliferous cones, or those in which the central axis is prolonged beyond the bracts and scales, it may be said that they are not uncommon, it being rare in some seasons to meet with a tree of *Cryptomeria japonica* in which some of the cones are not so altered. With the exception of *Sciadopitys*, to which special attention must be given, the ap-

pearances presented by these proliferous cones in various genera are essentially similar. The bracts become more or less leafy, and, indeed, those at either end of the cone pass gradually into the condition of ordinary leaves, so that the general appearance is as a branch growing through a cone.

In *Tsuga Brunoniana* the bracts are completely metamorphosed into leaves, while the scale is reduced to a lenticular process destitute of ovules and almost, if not wholly, detached from the bract (fig. 21).

The fruit-scales sometimes disappear gradually, at others

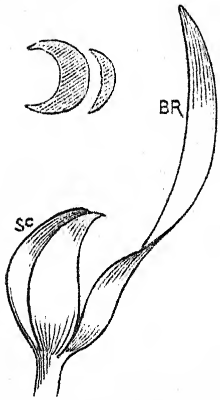


Fig. 21.—*Tsuga Brunoniana*, showing leafy bract edtached from the fruit-scale, which is barren. Enlarged.

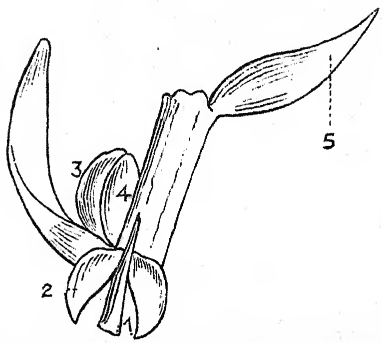


Fig. 22.—Portion of the cone of a Proliferous Larch. 2 is a fruit-scale in the axil of an unchanged bract; at 3 the leafy bract encloses at 4 a sterile fruit-scale; at 5 the scale has disappeared entirely. Enlarged.

they are more or less changed, while in still other cases they are not appreciably altered. Thus in a proliferous larch-cone I found the woody scales more or less winged at the sides, notched and bipartite *, and sometimes at the bottom of the notch a short cylindrical column was present, suggestive of the axis of a rudimentary bud, a matter of some significance in relation to the view taken of the nature of the fruit-scale by Caspary and others, to be hereafter alluded to (fig. 23, p. 316). Sometimes

* Compare this with the divided fruit-scale of *Schizolepis Braunii* figured in Renault, Cours de Botan. Fossil. Conif. tab. 12. ff. 1–4.

the lateral lobes of the scale were infolded so as partially to conceal the ovule at the base and suggest the idea of a partially closed carpel.

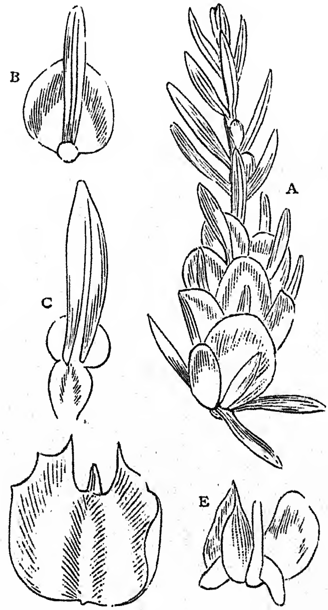


Fig. 23.—*Larix*. A, proliferous Larch-cone; B, leafy bract and seed-scale; C, leafy bract, the scale rudimentary; D, E, abnormal scales with traces of ovules. Real size.

The proliferous cones of *Pseudotsuga Douglasii* are chiefly remarkable for the fact that in passing into the leafy state the bracts gradually lose the three-lobed apex which usually characterizes them.

In the herbarium of Linnæus preserved in the rooms of the Society is a specimen of the Common Spruce (*Picea excelsa*) in which the fruit-scale within the bract, and seen from without, is represented by a central axis with a lobe on each side. Looked at from the inner side the two side-lobes are seen to be united at the base by a transverse band and to form with the central lobe a cup, occupied by a scaly bud the source of whose origin is doubtful. The explanation seems to be that there is a central axis bearing on each side a leaf or leafy process. These processes

are erect, appressed, and somewhat conduplicate or involute, the posterior edge of one united below with the posterior edge of the

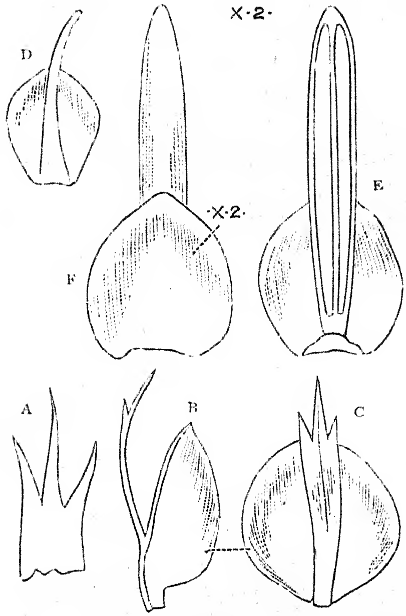


Fig. 24.—Details from a prolified cone of the Douglas Fir. A, normal bract; B, the same, seen from the side, attached to the scale at the base; C, bract and seed-scale, from the outside; D, bract from a proliferous cone passing into leafy condition; in E, F the bract is completely leafy, E seen from the outside, F from the inside.

other to form a sheath surrounding the bud. They may be considered as leaves or, as seems more probable, as wing-like projections from the axis (fig. 25).

This malformation is similar to those described and figured by Oersted *, by Stenzel, Willkomm, Eichler, and others, in which,

* Oersted, *l. c.* tab. i. figs. 1–15. Stenzel in Nov. Act. Acad. Leopold.-Carol. Band xxxviii. (1876) tab. 4. Willkomm in Nov. Act. Acad. Leop.-Car. Band xli. ii. Th. *a* 2, Halle, 1880, c. tab. Eichler, "Ueber Bildungsabweichungen bei Fichtenzapfen," Sitzungsb. d. k. Akad. d. Wissenschaft. z. Berlin, January 1882; and "Entgegnung auf Herrn L. Čelakovsky's Kritik &c.," in Sitzungsb. d.

with various modifications of detail, a leaf-bud is found within the bract, taking the place of the fruit-scale and possibly in some

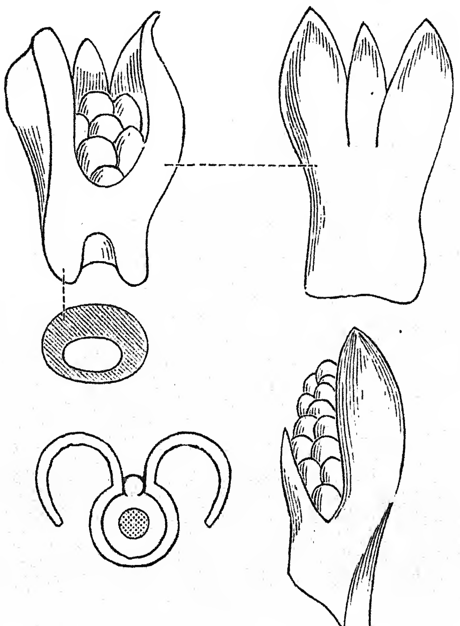


Fig. 25.—Monstrous flowers of *Picea excelsa*, in the herbarium of Linnæus. (For explanation see p. 316.)

cases developed from it. This latter conclusion, however, is contested by Eichler, who considers these buds to be purely adven-

Gesellsch. naturforsch. Freunde zu Berlin, June 20, 1882. Čelakovsky, Zur Kritik der Ansichten von der Fruchtschuppe, &c. (1882); and also the same author's reply to Eichler,' Ueber Herrn A. W. Eichler's Entgegnung,' &c., Prag, 1882. Velenovsky, "Zur Deutung d. Fruchtschuppe der Abietineen," Flora, 1888, p. 516, c. tab., a paper published since this communication was written, considers the normal fruit-scale to consist of two united leaves proceeding from a shoot arrested in its growth.

titious productions having no direct relation to any of the normal structures *.

Eichler had the opportunity of examining and of comparing nearly all the cones studied by his predecessors, and gives drawings representing various stages of malformation from a slight notching of the apex of the fruit-scale to its division into three parts, one posterior and two lateral, and the formation of a bud, or even of a shoot, from the internal portion of the posterior lobe. In the instances examined by myself I have not been able to ascertain satisfactorily the precise origin of the adventitious shoot.

Eichler's general conclusions are that the fruit-scale is not a complex organ, but an outgrowth from the bract, so that the bract and the fruit-scale are not two different organs, but parts of one; and that the bud or shoot, which in these proliferous cones is often produced in the axil of this bipartite body, is the development of an axillary bud usually latent. This bud may appropriately be compared to the buds formed at the summit of the branches in *Lycopodium Selago* † and on the leaf of *Isoëtes*.

In *Lycopodium* the sporangium is axillary and erect, often supported on a short stalk. The adventitious buds, above named, are also stalked and flattened in the median plane (as the fruit-scale of the cone is). From the side of the stalk emerge the leaves in decussate pairs, the two lateral leaves of the lowest pair being equal; the anterior leaf of the pair next above is larger than the posterior. The members of the succeeding lateral pair are equal; of the fourth pair (median) the anterior one is larger than its fellow, and each appears to arise from the base of the cup formed by the succeeding fifth pair. This fifth pair is lateral, and its components are greatly larger than any two that precede or follow them, and they are so twisted at the base that the surfaces, instead of being in the horizontal plane, are turned nearly into a vertical position and directed antero-posteriorly. More-

* Compare Eichler, Entgegnung, *l. c.* p. 81, figs. i., ii., and p. 92, figs. v.–x.; also the same author's "Bildungsabweichungen," *l. c.* figs. 2–12, and of which fig. 6 almost precisely resembles the condition in the Linnean specimen; figs. 5 and 7 also present a close resemblance. These figures are taken from specimens derived from the Botanic Garden of Upsala, whence possibly the Linnean specimen may also have been derived.

† For an account of these buds in *Lycopodium* see:—Dillenius, Historia Muscor. 436; Newman, History of British Ferns (1844), p. 379; Hegelmaier in Botan. Zeitung (1872), n. 45, and (1874) p. 513.

The buds of *Isoëtes* are described by Goebel in 'Botanische Zeitung,' 1879, n. 1, and in 'Outlines of Classification &c.' ed. Balfour, Oxford (1887), p. 295.

over, these two leaves are concrescent at the base so as to form a shallow cup from the outer side of which, a little above its base, emerge, as has been said, the two leaves constituting the pair immediately beneath and which have probably been uplifted by the vigorous basal growth of their larger neighbours.

The leaves of the sixth pair are median, and this time it is the posterior of the two which is the larger, whilst the smaller anterior one is uplifted with the base of its neighbour and with it forms a shallow cup. The next two leaves are lateral and slightly unequal; the next succeeding, eighth pair is median, and of these the anterior leaf is the larger.

Between the third and fourth pairs of leaves the internode is rather more lengthened than between the other pairs, and this allows of the separation as a "gemma" of the upper portion of the bud.

This description from living specimens differs somewhat from that of Newman, and is introduced here with the view of inducing future observation as to whether there is anything more than superficial resemblance between these buds and the adventitious ones that are formed in some proliferous cones.

Goebel describes the formation of buds or shoots in *Isoëtes* at the position on the leaf where a sporangium is usually found, and this shoot separates from the mother-plant and develops into a new plant, as in the case of the *Lycopodium* just mentioned.

In both these instances the formation of adventitious buds seems, like that in the prolified cones, to be due rather to substitution than to any actual metamorphosis of the sporangium, or even of the axis bearing it.

Parlatore * describes and figures a cone of *Pinus Lemoniana* in which the lower scales are changed into branches with leaves, and a cone of *Abies Brunoniana* affected in a similar manner.

In *Sequoia gigantea* M. Carrière has figured a cone with both leafy and axillary prolification †.

The proliferous cones of *Sciadopitys* are of great interest (figs. 26 and 27). In the ordinary cones of this plant the bracts are nearly completely concrescent with the fruit-scale, but in the specimen in question the bracts and the fruit-scale are more or less detached one from the other. Moreover, the bracts gradually assume the condition of the perulæ such as surround the buds. In this plant, then, the bracts, in place of becoming more leafy, as they do usually in proliferous cones, revert to the vaginal or perular condition. The metamorphosis is in this case retrograde instead of progressive, or, to speak more correctly, development has been arrested instead of enhanced. From the axil of each of these perulæ proceeds a

* Parlatore, Studi Organografice delle Conifere (1864), p. 35.

† Carrière in Revue Horticole (1887), p. 509, fig. 103.

" needle " or phylloid shoot of the ordinary character, so that in these cones we have it in evidence that the perulæ are modifications of leaves, that the needles or phylloid shoots are axillary to

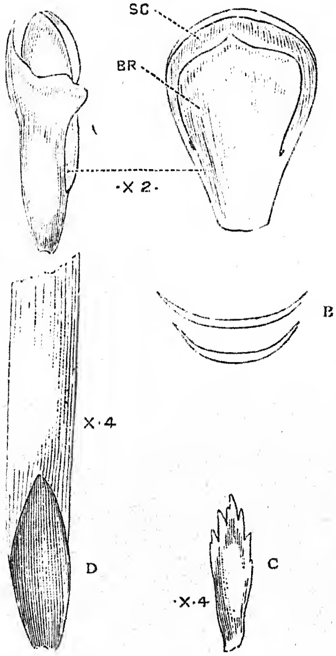


Fig. 26.—Details from prolified cone of *Sciadopitys.* A, bract and scale from the side and from the back respectively; B, section of A, to show detachment of scale and bract; C, bract; D, bract and portion of "needle" from proliferous cone, seen from the back.

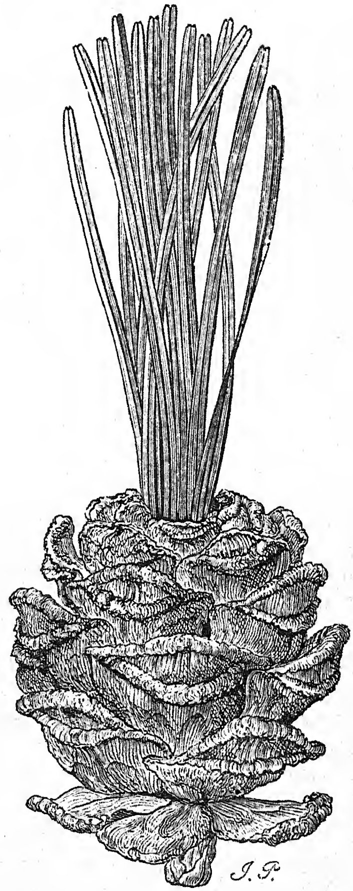


Fig. 27.—Proliferous cone of *Sciadopitys.* (From Veitch's 'Manual of Conifers.')

them, that they occupy the same relation to the perula that the fruit-scale does to the bract in ordinary cases, and, further, that

they have the same essential structure as the fruit-scale of this and all other genera.

The last malformation that needs mention here is one in *Pinus muricata*, in which a sort of false cone was produced consisting entirely of bracts which were arranged in spirals consecutively with a number of brown membranous scale-leaves on the stalk. The bracts were thick and spongy, green at the base and purplish brown at the tips, and each was traversed by a single fibro-vascular bundle proceeding direct from the axis. No trace of fruit-scale or of ovule was to be seen. Whether such a production would have been formed later on is doubtful.

Before leaving the subject of malformations it is as well to mention the peculiar cone-like galls made by certain Aphides (*Chermes*). These are exceedingly common on the Larch and Spruce, and might have been passed without comment but for the fact that a genus was founded on them by one of our most distinguished botanists.

Ovules and Seeds.

Throughout this communication the gymnospermy of the Conifers and their intimate relation to some of the Vascular Cryptogams has been taken for granted. It is not the writer's intention in this place to enter upon the consideration of these branches of the subject, which is amply discussed, so far as our existing knowledge permits, by Strasburger, Eichler, Baillon, and other botanists frequently mentioned in the course of this paper.

The most noteworthy characteristics from our present point of view are the presence of an aril in most Taxaceæ and Podocarpeæ, and its absence in the other suborders. The erect or inverted position of the ovule is also evidently significant, as the whole order may be subdivided into two groups by this character. The number of the ovules varies, as has been shown. Sometimes it is solitary, as in *Taxus*; in *Actinostrobus*, *Libocedrus*, some species of *Thuya* and *Chamæcyparis*, there are two (rarely more) seeds to each scale. In *Thuyopsis* there are four or five seeds, while in *Callitris* and *Cupressus* they are numerous. In *Taxodium* there are but two ovules, while in *Cryptomeria*, *Sequoia*, and *Athrotaxis* there are several.

In Araucariæ, *Araucaria* and *Agathis* have solitary ovules,

while *Cunninghamia* and *Sciadopitys* have several. All the Abietineæ have two ovules only.

The relative position of the ovules and their arrangement when reduced in numbers have been alluded to under the head of *Sciadopitys*. Mention may also here be made of the arrangement of the ovules in *Callitris* and *Cupressus*. In the young state the ovules are crowded at the base of the fruit-scale, but as the scale grows older it grows in length and the ovules are carried up with it. An examination of the ovules in these plants or of the scars whence they have fallen, seems to show that the arrangement is one of decussating pairs, modified by pressure and compulsory arrangement in one plane: thus two lateral ovules are succeeded by one median one, its fellow being suppressed; above the median ovule come two more lateral ones, and so on. In the *Sciadopitys* just alluded to the arrangement was centrifugal or cymose.

As the ovules ripen into seed they sometimes becomes fleshy; thus the seeds of *Ginkgo*, *Cephalotaxus*, and *Torreya* (figs. 28 and 29) closely resemble those of *Cycas*, there being a fleshy covering enveloping a woody shell, within which is the perisperm

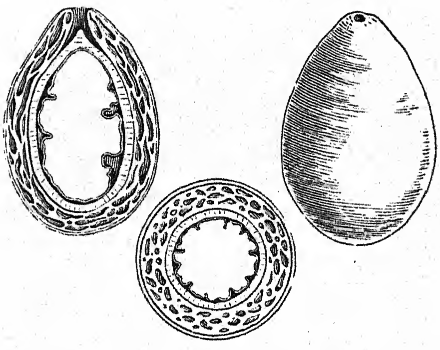


Fig. 28.—Seed of *Torreya grandis* and sections.

(prothallus), covered by a thin membrane adherent beneath to the woody shell, so that on opening the latter the lower part of the perisperm is bared, while the upper part is clothed with a membranous cap exactly as in *Cycas*.

In other instances the test of the seed expands into wing-like expansions at the top, as in *Pinus*, *Agathis*, &c., or at the sides, as in *Thuya*, *Cupressus*, &c.*

Fig. 29.—Seed-bearing shoot of *Cephalotaxus pedunculata*. Seeds fleshy, olive-coloured.

Dispersion of the Seed.—Various provisions are met with to serve this end. The fleshy aril of the Yew, the dilated stalk of *Podocarpus*, the pulpy seed of *Ginkgo* and others, the succulent fruit of *Juniperus*, may all facilitate the dispersion of the seed by birds.

* See Bertrand, "Teguments séminaux des Gymnospermes," Ann. Sc. Nat. 1878), p. 88.

The winged seeds also seem to afford ample provision for dispersal. In some cases (*Abies*) the seeds are liberated by the loosening and falling away of the fruit-scales; in other cases (*Picea*) the fruit-scales simply separate for a short space, whilst in some species of *Pinus* the cones remain attached to the branches with their thick woody scales firmly closed for an unlimited period, only opening, as it would appear, when the forest-fires cause them to split asunder and liberate the seeds. It is noted that the trees in these forests are all of about the same age and dimensions, a fact accounted for by the circumstances just mentioned.

That the scales of the young cone should separate one from another at the tips to permit of the ingress of pollen is readily intelligible; but the corresponding movements to facilitate the egress of the seeds are not so well known. I have no experience of my own to offer on this subject, but the following extract from a communication of Mr. Albert Prentiss on the Hygroscopic Movements in the Cone-scales of Abietineæ may be read with interest :—

"In most of the Abietineæ, soon after the maturation of the cones, the persistent scales fall backward or outward from the axis to permit the ripened seed to escape. The scales are very sensitive to moisture, and in many species exhibit very rapid movements when wet, as with rain. This is especially well seen in the cones of *Tsuga canadensis*, in which the widely open scales become completely closed in twelve minutes. This property of the cone-scale is found to be very efficient, first in loosening the winged seeds from the scale which bears them, and secondly in favouring the wide dispersion of the seed as the cones open and close many times before all the seeds are sown, thus securing their transport in different directions by the varying winds" *. In Museums it is a common practice to restore the original form of a cone in which the scales have separated one from the other from drought by soaking it in water.

* Prentiss, in 'Botanical Gazette' (1888), pp. 236, 237.

General Review of the Nature of the Female Flower.

The comparative examination of the female flower under various aspects—morphological, teratological, developmental, and structural—that has now been attempted, though naturally incomplete, and possibly incorrect in some of its details, permits of a general review being made. In all cases the ovule is the essential part of the flower. This is subtended in all cases by a bract, and is generally borne upon a "fruit-scale." The bract may be a mere scale or it may be leaf-like or woody or succulent, but it has invariably the relative position, disposition, and essential anatomical characters of a leaf. This is admitted by all botanists. The discrepancies and variations of opinion which have given rise to such a voluminous mass of literature concern what is here called the fruit-scale. As this has been throughout referred to incidentally, it is not necessary in this place to occupy space with a detailed account of the views held by each observer, the facts and arguments he adduces in their support, or to increase the length of this communication by citing the corresponding arguments used in their refutation by other observers *.

Suffice it to remark that what is here termed the fruit-scale, "*lamina ovulifera*," is almost invariably, perhaps always, present in some guise or other. It is scarcely if at all visible *externally* in the verticillate Cupressineæ, hardly more so in *Agathis* or *Cunninghamia*. In other Cupressineæ, such as *Libocedrus*, in *Araucaria*, *Sciadopitys*, and most Abietineæ it forms the larger and more conspicuous part of the ripe cone. In some genera, as before cited, it is not apparent on the surface; in others it exists as a thin membrane, in others as a spongy substance or a thick woody mass. In some it seems to be quite distinct and separate from the bract; in others it is more or less completely inseparate from it. One constant feature it presents wherever development has gone on sufficiently for the differentiation of vascular and bast tissue, and that is that the orientation of the vascular or xylem elements and that of the bast or phloem tissue respectively is exactly the reverse of what is met with in true leaves. For the rest it has been considered either

* The history of the subject may be found in the several papers of Strasburger, Eichler, Dickson, Čelakovsky, and others before referred to.

as a leaf or leaves, as a shoot with or without leaves, as an outgrowth from a leaf or from an axis, or as something neither truly foliar nor strictly axial:—thus it has been considered as a leaf (Richard, Lindley); an open carpellary leaf (R. Brown); a ligula, enation, or placental outgrowth from the bract-leaf (Sachs, Eichler); a "dédoublement" of the bract (Brongniart); a pair of leaves belonging to an otherwise undeveloped shoot and more or less coherent and twisted out of place, a view held with more or less modification of detail by R. Brown, Von Mohl, A. Braun, Caspary, Oersted, Parlatore, Van Tieghem, Stenzel, Willkomm, Engelmann, Čelakovsky, and Velanofsky; a disk-like outgrowth from the axis of a leafless shoot axillary to the bract (Strasburger); a rachis (F. von Mueller); a cladode (Schleiden, Baillon, Dickson, Arcangeli).

It may be observed that these opinions are not really so diverse as they appear to be, for every one of them is supported by some fact or other beyond dispute, yet also by assumptions of more or less doubtful validity and by arguments more or less partial in their application or untenable in the light of more recently acquired knowledge. Embarrassed by such conflict of opinion, some have tried to evade the difficulty by the assumption that the organ in question has a distinct morphological significance in different genera. The substantial uniformity of anatomical structure throughout the whole series, however, seems to negative this suggestion, and to show that what it is in one member of the order that it is, with more or less modification, in all.

While anxious to add to our store of facts I should hesitate to indulge in any hypothetical explanation of them that was materially at variance with any proposed by more competent botanists. Chiefly because it is scarcely if at all inconsistent with any of them and involves no unproven assumption, I venture to offer the following hypothetical explanation for consideration. The facts detailed in former pages show beyond dispute that the fruit-scale is something superadded to the bract; that it may arise as an enation either from the base of the bract or apparently from the axis just within or above it; that its structure is neither that of the leaf proper nor that of an ordinary shoot, but that it does present close resemblance in structure with a cladode as described by Dickson.

Reverting for a moment to Casimir de Candolle's 'Théorie de la feuille,' it may be remembered that this botanist compares the leaf to an axis, the *upper half* of whose vascular system is abortive or undeveloped, for which reason the xylem is towards the upper or inner surface, the phloem towards the lower. Apply a similar explanation to the fruit-scale, and the position of xylem and phloem becomes intelligible. According to this view the fruit-scale is an enation, either from the bract or from the axis, it is immaterial which, of the nature of a cladode or modified shoot. The *lower or outer* portion of this branch or cladode is abortive, and consequently the xylem is towards the lower or outer, the phloem towards the upper or inner surface.

As the bract-leaf and the fruit-scale are in close apposition in the young state, considerations of space and exigencies of packing in small compass would bring about the reduction or obliteration of the two opposed surfaces, just as in synanthic flowers it usually happens that one or more of the originally contiguous parts is as it were squeezed out of existence. Suppose such synanthy to become hereditary—as the bract and fruit-scale have become—there would then be no present process of obliteration—abortion would have given place to entire suppression, and each organ or member, bract, or fruit-scale, would be defective by reason of the hereditary non-development of some portion of its tissue.

Such an explanation of the nature of the fruit-scale appears to me to be consistent with the facts of morphology and anatomy, and not essentially inconsistent with any of the published explanations that are not merely conjectural but based on ascertained facts, and moreover it does not necessitate any postulates or unproven assumptions.

CONTENTS.

A Revision of the British Willows.

By F. Buchanan White, M.D., F.L.S.

[Read 6th June, 1889.]

(Plates IX.–XI.)

I. Introductory.

"Hunc locum sibi postulat Salicum familia, quæ si ulla in Botanicis obscura, hæc sane maxime," wrote Linné in the 'Flora Lapponica,' and the unanimity with which all salicologists have echoed the sentiment is eminently suggestive. For the following attempt at a revision of the British Salices I would therefore bespeak a lenient criticism on the part of those interested in the subject.

Though the verdict, pronounced some years ago by one of the most eminent of our botanists*, that the "definition and classification of Willows has long been a disgrace to systematic botany," is still too true, it must not be forgotten that in the early post-Linnean days of botanical science much good work was done by British salicologists. "Full thirty years," says Sir J. E. Smith, "have I laboured at this task" (of specific definition), "ten of them under the instructive auspices of my late friend Mr. Crowe, in whose garden every Willow that could be got was cultivated. . . . . The plants were almost daily visited and watched by their possessor, whom no character or variation escaped; seedlings innumerable, springing up all over the ground, were never destroyed till their species were determined, and the immutability of each verified by our joint inspection. This was the more material, to set aside the gratuitous suppositions of the mixture of species, or the production of new or hybrid ones, of which, no more than of any change in established species, I have never met with an instance." (Eng. Fl. iv. p. 164.)

In the work just cited 64 "species" of British Willows are described, a number which may be contrasted with the 30 of Babington's 'Manual' (8th edition, 1881), and the 18 of Hooker's 'Student's Flora' (3rd edition, 1884); but since in the latter hybrid forms are not numbered, the comparison with the former is more just.

Smith's species were not suppressed all at once. The salicologists who followed him were rightly so imbued with a consciousness of his great labours, that they were naturally averse

* Professor Babington, in Journ. Bot. i. (1863) p. 167.

to differ from him without good reason, though some of them "could never satisfy" themselves as to the characters of some of the supposed species.

The accompanying Table (Plate IX.) will show, in a perspicuous manner, the very different views, as regards the number of British Willows which have been held at various times. The shaded columns show the quantity of numbered "species" at each period. The darkest portion indicates the number of true species included in each estimate; the medium the number of what are now (in this paper) recognized as hybrid forms ; and the lightest the number of supposed species, but which are now considered to be forms only, or, if species, have no claim to be regarded as natives of Britain.

The periods are as follow:—

1762. Hudson, 'Flora Anglica.' 18 species (10 true, 1 hybrid). Hudson's *S. reticulata* is a form of *S. herbacea*.

1804. Smith, 'Flora Britannica,' vol. iii. 45 species (16 true, 3 hybrids).

1828. Smith, 'English Flora,' 2nd ed., iv. 64 species (17 true, 6 hybrids).

1830. W. Withering, Jun., 'Arrangement,' 7th ed. 52 species (17 true, 6 hybrids).

1835. Lindley, 'Synopsis,' 2nd ed., and 1841, 3rd ed. 30 species (17 true, 5 hybrids).

1838. W. J. Hooker, 'British Flora,' 4th ed. 70 species (17 true, 18 hybrids).

1860. Hooker and Arnott, 'British Flora,' 8th ed. 38 species (17 true, 6 hybrids).

1873. Boswell, 'English Botany,' 3rd ed. 34 species (17 true, 10 hybrids).

1881. Babington, 'Manual,' 8th ed. 30 species (17 true, 7 hybrids).

1884. J. D. Hooker, 'Student's Flora,' 3rd ed. 18 species (16 true, 1 hybrid).—In this work supposed hybrids, though mentioned, are not numbered; and *S. cinerea* is treated as a subspecies.

1886. 'London Catalogue,' 8th ed. 31 species (17 true, 7 hybrids).

1890. As set forth in this paper, 58 forms (17 species, 41 hybrids).

From this statement it will be seen how great the range of opinion has been during the present century, the estimated number of "species" varying from 70 in 1838 to 18 in 1884!

But though since 1838 so many names have disappeared as the names of species, many of them are not only still retained in our lists as those of varieties, but have been added to; so that in the last edition of the 'London Catalogue' there are no less than 96 named willow-forms included under 31 species.

The object, therefore, of this Revision is in the first place to consider how many of these names deserve retention; and in the second to point out the occurrence in Britain of some hitherto unrecorded hybrids.

In endeavouring to carry out this intention it has happened that I have had occasionally to criticise the work—either the descriptions or the determinations of specimens—of some of the great salicologists; and I wish to state, though I daresay it is unnecessary, that such has been done in no carping spirit.

For the sake of brevity, I have not cited at length under each species the works chiefly consulted, but have referred to them simply by the names of the authors. The abbreviations thus used are as follow:—

Andersson. (N. J. Andersson, 'Monographia Salicum,' 1867.)—Of this great work, which, with Wimmer's 'Salices,' is of the utmost importance to the student of Willows, the first part only was published. The remaining species, as well as some rather later views of the author, are given in De Candolle's 'Prodromus,' pt. xvi. section 2, 1868; and for all species after and inclusive of the *Viminales* the citation "Andersson" refers to the 'Prodromus.' Other works of the same author which have been consulted are the 'Salices Lapponiæ,' the genus *Salix* in Blytt's 'Norges Flora,' pt. ii. 1874; and the notes made on Leefe's 'Salictum Britannicum,' and communicated by H. C. Watson to the 'Botanical Gazette,' May 1851.

Babington. (Professor C. C. Babington, 'Manual of British Botany,' 8th ed., 1881.)

Boswell-Syme. (J. Boswell-Syme, 'English Botany,' 3rd ed., 1873.)

Forbes. (James Forbes, 'Salictum Woburnense,' 1829.)*

* For a large number of living specimens (from plants cultivated at Kew and probably originally derived from the Woburn collection), illustrating the species figured by Forbes, I am greatly indebted to Mr. George Nicholson.

J. D. Hooker. (Sir J. D. Hooker, 'Student's Flora,' 3rd ed., 1884.)

W. J. Hooker. (Sir W. J. Hooker, 'British Flora,' 4th ed., 1838. Borrer's opinion is frequently quoted in this work.)

Koch. (W. D. J. Koch, 'Synopsis Floræ Germanicæ,' 2nd ed., 1844.)

Smith. (Sir J. E. Smith, 'English Flora,' 2nd ed., 1828.)

Walker Arnott. (Hooker and Arnott's 'British Flora,' 8th ed., 1860, for which Dr. Walker Arnott was alone responsible.)

Wimmer. (F. Wimmer, 'Salices Europææ,' 1866.)

Any other works referred to (and many have been consulted) are cited at greater length.

In addition to consulting the descriptions, I have, when possible, compared our specimens with the examples published by several salicologists, and more especially by Wimmer. For an opportunity of doing so with great convenience, I am much indebted to the kindness of Mr. C. Bailey, who lent me his extensive collection of Willows, which includes, in addition to Wimmer's 'Collectio Salicum Europæarum,' many examples published by A. and J. Kerner, Reichenbach, &c.

Other specimens examined include Linné's own herbarium, belonging to the Linnean Society *; Smith's, also in the possession of that Society; some specimens of Smith's attached, with notes, to the original drawings for 'English Botany,' preserved at the British Museum; the British Museum and Kew Herbariums; the British Willows of Edinburgh University Herbarium (kindly lent me by Professor Bailey Balfour); and several private herbariums, some of which contain, in addition to the specimens published by the Rev. J. E. Leefe, other examples received from that botanist. Mr. Leefe's specimens are valuable, not only as showing his own and Ward's opinion on many British Willows, but as illustrating the species of Smith and the views of Borrer.

Besides the specimens just mentioned, I have examined in a living condition several thousand examples, either collected by myself, or sent to me by friends and correspondents, to whose kind services I am much indebted, and whose names are mentioned under the species of which they have provided me with much-needed specimens, either living or dried.

* For information regarding the labels of this collection I am greatly indebted to Mr. Daydon Jackson.

II. Classification.

Various arrangements of the Willows have been proposed; but perhaps the best is that of Andersson, though even that is not altogether satisfactory.

Andersson arranges the species in three tribes :—A. *Pleiandræ*, B. *Diandræ*, C. *Synandræ*.

The essential characteristics of the *Pleiandræ* lie in the pale unicolorous scales, which fall off before the fruit ripens; in the stamens being most usually not less than three in number; and in the nectary being commonly double.

The *Diandræ* are distinguished by having the scales, which are more or less darker-coloured in the upper part, persistent with the fruit; the stamens two in number and with free filaments; and the nectary very rarely double.

The *Synandræ* may be recognized by the filaments of the two stamens being more or less connate.

Now whilst these points are, in the main, characteristic of each tribe, they are not such decided distinctions as might be desired. In the *Pleiandræ*, for example, the stamens, though described as free, are not so in every species; since in some, as in *S. fragilis,* they are, or appear to be, connate at the very base when viewed from the back—from the front the adnate anterior nectary conceals the union; the nectary, though often double, is in one sex of some species single only; and the stamens in some species are almost constantly two in number. Moreover, the scales in some species of both the other tribes are unicolorous.

Andersson subdivides his three tribes into sections, and these again into groups. In the *Pleiandræ* there are two sections—the *Tropicæ*, with four groups, and the *Temperatæ* with three, namely, 5. *Amygdalinæ* or *Triandræ*, 6. *Lucidæ* or *Pentandræ*, and 7. *Fragiles* or *Albæ*. The *Diandræ* are divided into the *Microstylæ* (which includes 8. *Longifoliæ*, 9. *Cinerascentes* or *Capreæ*, 10. *Roseæ*, and 11. *Argenteæ* or *Repentes*); the *Podostylæ* (12. *Virescentes* or *Phylicifoliæ*, and 13. *Rigidæ*); and the *Macrostylæ* (14. *Pruinosæ*, 15. *Micantes* or *Viminales*, 16. *Niveæ*, and 17. *Nitidulæ*). The *Synandræ* have two groups only—18. *Incanæ*, and 19. *Purpureæ*.

Adopting Andersson's arrangement, but using in some cases his second name for the group as being more instructive, the British Willows may be classified as follows :—

A. PLEIANDRÆ.

1. Triandræ.

1. *Salix triandra*, L.
× *Salix decipiens*, Hoffm.
× *Salix subdola*, B. White.
× *Salix undulata*, Ehrh.

2. Pentandræ.

2. *Salix pentandra*, L.
× *Salix cuspidata*, Schultz.
× *Salix hexandra*, Ehrh.

3. Fragiles.

3. *Salix fragilis*, L.
b. *britannica*, B. White.
4. *Salix alba*, L.
b. *vitellina*, L.
× *Salix viridis*, Fr.

B. DIANDRÆ.

4. Capreæ.

5. *Salix cinerea*, L.
6. *Salix aurita*, L.
× *Salix lutescens*, A. Kern.
7. *Salix Caprea*, L.
× *Salix Reichardti*, A. Kern.
× *Salix capreola*, J. Kern.

5. Repentes.

8. *Salix repens*, L.
× *Salix ambigua*, Ehrh.
× *Salix cinerea-repens*, Wimm.
× *Salix Caprea-repens*, Lasch.
× *Salix nigricans-repens*, Heidenr.

6. Phylicifoliæ.

9. *Salix phylicifolia*, L.
a. *S. phylicifolia*, L., auct.
b. *S. nigricans*, Sm.
c. *S. phylicifolia-nigricans*, Wimm.

× *Salix laurina*, Sm.
× *Salix Wardiana* (Leefe, MS.), B. White.
× *Salix ludificans*, B. White.
× *Salix tephrocarpa*, Wimm.
× *Salix latifolia*, Forbes.
× *Salix strepida* (Schleich.), Forbes.
× *Salix coriacea* (Schleich.), Forbes.
10. *Salix Arbuscula*, L.
× *Salix Dicksoniana*, Sm.

7. Viminales.

11. *Salix viminalis*, L.
× *Salix Smithiana*, Willd.
a. *stipularis* (Sm.).
b. *sericans* (Tausch).
c. *velutina* (Schrad.).
d. *ferruginea* (G. And.).
e. *acuminata* (Sm.).

8. Niveæ.

12. *Salix lanata*, L.
b. *Sadleri* (Syme).
× *Salix superata*, B. White.
× *Salix Stephania*, B. White.
13. *Salix Lapponum*, L.
b. *helvetica* (Vill.).
× *Salix aurita-Lapponum*, Wimm.
× *Salix cinerea-limosa*, Læstad.
× *Salix spuria* (Schleich.), Willd.

9. Nitidulæ.

14. *Salix Myrsinites*, L.
× *Salix Wahlenbergii*, And.
× *Salix saxetana*, B. White.
× *Salix serta*, B. White.
15. *Salix herbacea*, L.
× *Salix Grahami* (Borr.), Baker.
× *Salix Moorei*, "Watson, L. C."
× *Salix simulatrix*, B. White.
× *Salix sobrina*, B. White.
× *Salix margarita*, B. White

16. *Salix reticulata*, L.
× *Salix semireticulata*, B. White.
× *Salix sibyllina*, B. White.

C. SYNANDRÆ.

10. Purpureæ.

17. *Salix purpurea*, L.
× *Salix rubra*, Huds.
× *Salix sordida*, Kern.
× *Salix dichroa*, Döll.
× *Salix Doniana*, Sm.

It will be noticed that in this list one willow, generally included in British catalogues, has been omitted. This is *S. daphnoides*, Vill., which, though not unfrequently planted, can in no way be claimed as an indigenous plant.

It will also be noticed that in a very few cases only are varieties distinguished by name. "Varieties," "forms," and "modifications" of almost every species and hybrid have at one time or other been described; but since the forms so separated have, in the vast majority of cases, no constancy, but pass by imperceptible gradations the one into the other, their retention is a hindrance rather than a help. In the few instances where I have distinguished varieties, these have not all quite an equal rank; but their value will be indicated as each of them is specially discussed.

I may also state that I shall only occasionally allude to gynandrous forms, though in many cases names have been bestowed on them. A number of species have not very unfrequently a mixture of male and female flowers in the same catkin, whilst others have their floral organs quite monstrous. Such forms, though of considerable interest, ought not to be distinguished by name.

III. Hybridization.

In addition to the really great variability of the true species and consequent difficulty in attaining a satisfactory knowledge of them, the fact that Willows hybridize with the greatest facility adds immeasurably to the intricacies of the study. The earlier salicologists were mostly unwilling to recognize the pos-

sibility of hybridization, though such had been suggested; for Smith writes of "the gratuitous suppositions of the mixture of species, or the production of new or hybrid ones."

At a somewhat later period, however, the probability of the phenomenon was admitted; but it was left to Max Wichura * to prove, by experiment, the truth of what had before been only—though on good grounds—suspected. Wichura found that not only did many binary hybrids occur naturally, but that ternary hybrids were also spontaneously produced. Binary hybrids are those produced by two species; ternary are those into whose composition three species have entered. In addition to this, he showed that by cross-fertilizing these hybrids, plants could be produced whose pedigree included no less than six species. (The accompanying diagram (Plate X.) shows graphically the pedigree of the compound hybrids.) Six species appeared to be the limit, as, from the imperfection of the pollen or of the seeds, the combination of species could not be carried further.

Theoretically, therefore, every species can form spontaneous hybrids with every other species; but practically hybrids are restricted by several causes. For hybrids to occur, not only must there be a certain degree of proximity of situation in the parents, but an identity in the period of flowering. Close proximity, though favourable for hybridization, is not absolutely necessary, since fertilization is accomplished by insect agency, and the attraction to insects of willow-flowers is very great. Identity of the usual time of flowering is an almost imperative necessity for the production of hybrids; but these also occur—though more rarely—between species which do not ordinarily flower at the same time, and must have been produced by some abnormality in the period of one of the parents. It must also be remembered that species, whose distribution is both lowland and alpine, have their time of flowering retarded in alpine situations, and are hence able to hybridize with the true mountain species.

A hybrid in its best condition is exactly intermediate in character between its two parents; but more frequently it shows a greater relationship with one rather than the other; and in those cases where it occurs in any abundance, a series of speci-

* 'Die Bastardbefructung im Pflanzenreich erläutert an den Bastarden der Weiden,' 1865.

mens can usually be obtained exhibiting a more or less perfect gradation from one parent to the other. Some of these are probably due to the fact that they are really crosses of the hybrid with one of the parent species; but this is not necessarily the case, since the influence of one parent may be stronger than that of the other; and differences may also result from an alteration in the sex of the parents. Thus, if A and B represent two species, then A ♂ × B ♀ may, it is supposed, produce a somewhat different-looking hybrid than A ♀ × B ♂ does.

To recognize a hybrid, the student must, in many instances, have an intimate acquaintance with the characteristics of the true species, more especially in the case of closely allied ones. This is very essential, since the books usually describe the more distinct forms only, and frequently seem to ignore the insensible gradations which connect the hybrid with its parents: not that they really ignore them, but from the difficulty of expressing in words characters that the trained eye can more or less easily perceive.

The rank to be ascribed to hybrids and the system of nomenclature to be adopted are points on which it is desirable that more unanimity and uniformity should obtain amongst botanists. Taking Nyman's 'Conspectus' as a sample of a not uncommon method, it will be found that some hybrids (e. g. *S. rubra* and *S. Doniana*) are given full rank and numbered as species; whilst others, of equal importance, have no such position. Some other authors merely indicate the occurrence of hybrids and do not describe them; whilst among those who give hybrids a rank nearly or quite equal to species, some, as Andersson, place them in the groups to which they are most entitled to belong, but others, as Wimmer, keep all the hybrids together.

Then as regards the nomenclature, Andersson and many others adopt distinct names, which do not in any way indicate the real or supposed parentage; but Wimmer, on the other hand, repudiates, as a rule, all such names, and uses for the hybrids a combination of the parental designations. In many respects there is much advantage in Wimmer's method; but even he has not been able to employ it uniformly, and was obliged to use other names in certain cases where the parentage is doubtful; and moreover in some instances the compound name that he has used is erroneous and misleading. Wimmer's plan also entails a breach of the law of priority. Under these circumstances, whilst

there is a decided advantage in employing a compound name—since it conveys distinct information—such can be used in those cases only where no earlier name exists, and *where there is no doubt about the parentage.*

Regarding the Rank and Position of Hybrids.—In the first place, they can scarcely be treated as mere varieties—much less ignored—if Willows are to be satisfactorily studied; on the other hand, neither can they be considered as equal to species. The title they should bear is that of "hybrid," and their ordinal position should be near the species to which they are allied. As to whether they should or should not be numbered, that is a matter of convenience; but their names should always have the prefix ×, as indicating the hybrid origin.

Since, theoretically, every species of *Salix* can hybridize with every other species, the 18 British species (giving *S. nigricans* specific rank for this occasion) should produce about 144 binary hybrids. As a matter of fact, about 61 real or supposed hybrids of these 18 species are known; but somewhere about 20 of these have not yet been detected in Britain. The species with which each of the 18 hybridizes are as follow:—

Triandra, with *fragilis*, *alba*, *cinerea*, *aurita*, *Caprea*, and *viminalis*.

Pentandra, with *fragilis*, *alba*, *nigricans*, and *Arbuscula*.

Fragilis, with *triandra*, *pentandra*, and *alba*.

Alba, with *triandra*, *pentandra*, and *fragilis*.

Cinerea, with *triandra*, *aurita*, *Caprea*, *phylicifolia*, *nigricans*, *repens*, *viminalis*, *Lapponum*, and *purpurea*.

Aurita, with *triandra*, *cinerea*, *Caprea*, *phylicifolia*, *nigricans*, *repens*, *viminalis*, *Lapponum*, *Myrsinites*, *herbacea*, and *purpurea*.

Caprea, with *triandra*, *cinerea*, *aurita*, *phylicifolia*, *nigricans*, *repens*, *viminalis*, *Lapponum*, and *purpurea*.

Repens, with *cinerea*, *aurita*, *Caprea*, *phylicifolia*, *nigricans*, *viminalis*, *Lapponum*, and *purpurea*.

Phylicifolia, with *cinerea*, *aurita*, *Caprea*, *nigricans*, *Arbuscula*, *repens*, *viminalis*, *Myrsinites*, and *herbacea*.

Nigricans, with *pentandra*, *cinerea*, *aurita*, *Caprea*, *phylicifolia*, *repens*, *Lapponum*, *Myrsinites*, *herbacea*, *reticulata*, and *purpurea*.

Arbuscula, with *pentandra*, *phylicifolia*, *Lapponum*, *Myrsinites*, *herbacea*, *reticulata*, and *purpurea*.

Viminalis, with *triandra, cinerea, aurita, Caprea, repens, phylicifolia*, and *purpurea*.

Lanata, with *herbacea* and *reticulata*.

Lapponum, with *cinerea, aurita, Caprea, nigricans, Arbuscula, repens, Myrsinites*, and *herbacea*.

Myrsinites, with *aurita, phylicifolia, nigricans, Arbuscula, Lapponum*, and *herbacea*.

Herbacea, with *aurita, phylicifolia, nigricans, Arbuscula, lanata, Lapponum, Myrsinites*, and *reticulata*.

Reticulata, with *nigricans, Arbuscula, lanata*, and *herbacea*.

Purpurea, with *cinerea, aurita, Caprea, nigricans, Arbuscula, repens*, and *viminalis*.

Whilst the foregoing list will serve to show the student what hybrids may be expected to occur, the accompanying diagram (Plate XI.) demonstrates the relation of both sections and species as regards hybridization. The larger circles indicate the sections, the smaller circles the species, and the lines connecting the latter show that these hybridize. As regards Britain, both the *Pleiandræ* and the *Synandræ* are lowland (*i. e.* not ascending above 1000 feet) in their altitudinal distribution ; but the *Diandræ* include both lowland and alpine species ; and the groups thus formed are indicated by dividing the circle by dotted lines and numbering the segments. I. includes *S. viminalis* only, which is strictly lowland. II. forms a group of which the species, though most common in the lowlands, ascend into the region of III., the strictly alpine species, rarely, if ever, descending to 1000 feet. IV., including *S. Lapponum* and *S. Arbuscula*, ought not perhaps to be separated from III., since these are very rarely otherwise than alpine in their distribution.

Though nine or more ternary hybrids occur spontaneously in Europe, none have been detected with *absolute* certainty in Britain, perhaps from the great difficulty attending their recognition.

IV. Collecting.

Since Willows produce their flowers either before the leaves or when the leaves are only young, and since mature leaves are necessary for the proper determination of the species, leaf-specimens and flower-specimens cannot be obtained at the same time ; hence, unless great care be taken, there is a real danger that the flowers of one bush and the leaves of another may be taken to represent one specimen.

In collecting, therefore, it is essential to guard against any intermixture of specimens. To do so, not only must the trees be marked, but the specimens taken from them be ticketed in such a manner as to prevent the possibility of mistakes. The method which experience has shown me to be a good one is as follows:—Provide a number of slips of paper 5 or 6 inches long by 4 inches wide, each with a long slit in it. On selecting a bush from which to take flower- or leaf-specimens, cut on the bark a number in Roman numerals *, put the same number on one of the slips of paper, and add a description of the situation of the bush; then having taken the specimens required, pass their ends through the slit and transfer to the vasculum. On returning home, enter in the "locality note-book" the number and other particulars of the bush, and prefix in Arabic numerals the note-book or permanent number. Write the latter on small bits of paper and fix one to every specimen before it is put in the press to dry. In this way all risk of confusion of specimens will be avoided.

Whilst the note-book numbers must run continuously, the bush-numbers can, for the sake of convenience, be repeated when the localities from which the specimens are obtained are sufficiently distinct.

Before pressing the specimens it is desirable to enter in the note-book such particulars of the plant as can be better seen in the living than in the dried condition. The importance of these will vary according to the species or group. In the *Synandræ*, for example, the extent of connation of the filaments and colour of the anthers (at different ages) are points to be noted in the living plant. The colours of the different parts, structure of the style, stigmas, and nectary, venation of the leaves (whether raised or impressed), surfaces (smooth or wrinkled), the margin (flat or incurved) are included in the characters which should be recorded in the note-book.

In drying, pressure sufficient, both in weight and continuance, to keep the leaves flat, without crushing the catkins too much, should be given. Some of the leaves, at various parts of the specimen, should be arranged so as to show the under surface. In selecting leaf-specimens side branches as well as terminal

* Herr Hauptmann Schambach, of Northeim, Hanover, has kindly suggested another method of preserving the identity of the bushes. He uses narrow strips of lead (stamped with a number) which can be twisted round a branch.

shoots should be taken. The latter alone are not sufficient, as they often have leaves somewhat different from the normal condition; on the other hand, they are useful for illustrating the stipules. Leaf-specimens should not be taken till the leaves are mature (since the young leaves are deceptive), and, if possible, not earlier than the middle of August. Male catkins should exhibit both unopened and opened anthers. Female catkins should be neither too young nor too old, but be just about the age of fertilization. Specimens in young fruit are also useful.

In studying Willows "a practised eye is," as Mr. Leefe says, "more to be relied on than the characters found in books;" since, as Fries remarks, "Characteres non specierum sunt criteria, sed ad species dignoscendas adminicula. Ex his modo species agnoscuntur, ex vegetationis cognoscuntur. . . . Hinc Linnæus in speciebus discernendis non characteres sed oculorum judiciique aciem laudat."

Whilst all parts of the plant are variable, some characters, on which a good deal of reliance has been placed, are so inconstant that they may, in many cases at least, be almost or quite ignored, though in other instances they are really of importance. Familiarity with the species can alone teach the student what are the points on which he can depend. In many species the presence or absence of stipules, and the shape of these organs, are of no great value for the discrimination of the plant; in others it is the very reverse. The presence or absence or the amount of pubescence is a character of similar value, as is the presence or absence of glaucosity.

V. Distribution.

Though it is probable that the records of distribution in Britain of the true species are, on the whole, correct, the range of the hybrids has yet to be worked out; and for the sake of accuracy it is perhaps expedient that a new census of the distribution of all the British Willows should be taken.

Perthshire is as rich as—probably richer than—any other county. All the seventeen true species and thirty-one of the hybrids occur in it; and since the neighbouring county of Forfar is probably nearly as productive, and has several hybrids which have not yet been detected in Perthshire, Central Scotland appears to be the metropolis of Willows in Britain.

VI. Revision of the Species.

A. PLEIANDRÆ.

Group 1. Triandræ.

1. Salix triandra, *L.*

Smith and his school of salicologists considered that the willow which is now known as *S. triandra*, included three, if not four, distinct species, viz. *S. triandra*, L., *S. amygdalina*, L., *S. Hoffmanniana*, Sm., and perhaps *S. contorta*, Crowe,—distinguished by the shape, size, and colour of the leaves, and nature of the shoots. Continental botanists, on the other hand, while not usually recognizing all these, separated from *S. triandra* several other forms. At the present day none of these forms are recognized as species, though most of them are retained as varieties, at least by the British school. Thus, in the last edition of the 'London Catalogue' four varieties of *S. triandra* are given, namely, a. *amygdalina* (L.), b. *Hoffmanniana* (Sm.), c. *Trevirani* (Spreng), and d. *contorta* (Crowe).

The majority of continental salicologists, as Koch, Grenier, and Andersson, make the more important varietal characters lie in the colour of the leaves, while Wimmer considers the shape to be of more value.

Andersson's leaf-varieties are α. *discolor*, Koch (underside of leaves intensely glaucous), and β. *concolor*, Koch (paler but not glaucous). Of each of these there are the forms 1. *latifolia*, 2. *angustifolia*, and 3. *microphylla*. He also gives two catkin varieties, γ. *tenuijulis* and δ. *crassijulis*.

Wimmer's varieties are α. *vulgaris*, β. *angustifolia*, and γ. *Villarsiana*, each with modifications according as the underside of the leaves is green or glaucous.

On the whole, Andersson's division into *discolor* and *concolor* seems to be the arrangement most worthy of retention; since an examination of any large series will show that the variations dependent upon shape, whether of the leaves or of the catkins, are all connected by intermediates and glide the one into the other. But the presence or absence of glaucosity is not a sufficiently stable character, either, upon which to found varieties; for, as Wimmer remarks, not only may glaucous and green leaves be found on the same plant, but even the same leaf may be partly green and partly glaucous below. It seems better, therefore, to place little importance on any of the so-called varieties—either British or continental—of *S. triandra*.

In Britain, judging from the specimens I have seen, *Salix triandra* exhibits fewer extreme forms of variation (though variable enough both in leaves and catkins) than it does in continental Europe. The 'London Catalogue' var. a. *amygdalina* seems to be equivalent to Andersson's *α. discolor*, which he says is *S. amygdalina*, auctorum (*S. amygdalina*, L., if not altogether dubious, is only a synonym of *S. triandra*); b. *Hoffmanniana* is *β. concolor*, 1. *latifolia* of Andersson; and c. *Trevirani* is a hybrid of *S. triandra* and *S. viminalis*, and will be considered hereafter. Specimens named by Leefe *S. contorta*, Crowe, do not altogether agree with Smith's description of that plant, which he says has leaves half the size of those of *S. triandra*. Leefe's *contorta* has long leaves, which in several ways suggest a cross of *triandra* with *fragilis*; but the catkins (♀) are in all essential particulars those of *triandra*, of which species it seems to be only a leaf-form.

Andersson is of opinion that his *discolor* is in Western Europe a more truly wild form than *concolor*, which is the more frequently cultivated one. In Britain *concolor* seems to be the commoner, and is more usually broad-leafed than narrow-leafed.

In Linné's herbarium there are not any specimens named *S. triandra*; but a plant labelled by Linné "hastata" (and by Smith "triandra ?") appears to be *S. triandra*, with leaves glaucous below; and another example, labelled by Linné "Salix pentandra" (to which Smith has put a "?"), and with, in another hand, a stuck-down label with "Salix pentandra, Flor. Lap. 370. Foliis subtus cinereis. No. 8," seems also most probably *S. triandra*, with leaves narrowed at each end and glaucous below.

× SALIX DECIPIENS, *Hoffm.* (*S. triandra* × *S. fragilis.*)

In his 'Historia Salicum" (vol. ii. fasc. i. p. 9, t. 31, 1791), Hoffmann describes and figures a willow, which he named *S. decipiens*, from the resemblance of the leaves to those of *S. bigemmis* (= *S. daphnoides*), and which, he says, is one of several species that go by the name of *S. fragilis*. Smith, amplifying the description, adopted Hoffmann's species, and was followed for a considerable time by British botanists. The more recent British authors have, however, placed *S. decipiens* as a variety of *S. fragilis*, and have omitted more or less to notice important points of its characteristics.

The continental salicologists, on the other hand, very soon began to consider *S. decipiens* as either a synonym (*e. g.* Willdenow, as also Lindley amongst British botanists) or as a mere variety

(*e. g.* Koch) of *Salix fragilis*. Wimmer, while citing the name as a synonym, adds, in his notes, that the plant he has described is the same as Hoffmann has figured, and that, though no adult leaves are depicted, yet it is evidently a broad-leaved form, which he considers to be the type of the species (*i. e.* of *S. fragilis*).

Andersson dismisses *S. decipiens* as only a slight modification of *S. fragilis*, analogous to the var. *vitellina* of *S. alba*, and produced, like that, by the annual lopping of the tree. The short description he gives is similar to that given by Koch.

A careful study of the figures and descriptions will, I think, suggest that the plant attributed by Andersson &c. to *S. decipiens* is not Hoffmann's species, but a modification only of *S. fragilis*, produced, as Andersson says, by annual cutting-over, and distinguished by the bark of the twigs being testaceous in colour, and the lower leaves more or less obtuse. No allusion is made, it will be noticed, to the remarkable "polish" of the twigs, nor to the inflorescence.

In Britain, however, the plant described and figured by Smith as *S. decipiens* (and which is beyond doubt Hoffmann's species) has been continuously known under that name, though the more recent writers have, in reducing it to the rank of a variety, omitted to notice some of its essential peculiarities, and have in fact apparently not observed them.

As a matter of fact, Hoffmann's *decipiens* seems to be little known and scarcely understood by continental salicologists. Andersson saw in H. C. Watson's herbarium * specimens published by Leefe †, and made no remark upon them, except that there were at Upsala two trees, planted by Linné, altogether like Leefe's plant, and that the form was very rare in Sweden. On this note Leefe and Ward make the following comment (Journ. of Bot. viii. p. 305): "certainly *decipiens*, E. B." Possibly the specimen (which, though in bad condition, seems to be quite the same as the British *decipiens*) in the British-Museum Herbarium, labelled "*Salix fragilis*, var. *decipiens*, Koch; Upsala; E. Fries (Herb. Norm.)," may be from one of these trees. Another specimen

* I have a Willow from Surrey, labelled by Watson "Salix undulata, *fide* Andersson," which, though it is a leaf-specimen only, I have no doubt is *S. decipiens*.

† No. 50 of original fasciculus. Leefe says, "buds black in spring"; but his specimens have pale buds. He also says, "In specimens received from Professor Koch the scales of the ♀ are round and very hairy; the leaves of the ♂ are broader and less glaucous and reticulated beneath than in my specimens; those of the ♀ agree exactly." So apparently Koch knew the plant.

(♂), in Kew Herbarium, collected by Fries at Upsala, and labelled *Salix decipiens*, Koch, seems to be also the same as our *decipiens*, but with leaves more in the direction of *fragilis*.

As corroborating the belief that our *decipiens* is not known, under that name, to Continental botanists, it may be mentioned that specimens quite the same as it were collected at Königsberg, and published as *S. fragilis* var. *porcellanea* by Baenitz. These Königsberg examples again bear a resemblance so sufficiently close as to suggest identity of species with a willow gathered near Hanover by Beckmann, and named *S. fragilis* × *triandra*, f. *androgyna* *.

From the study of a large number of specimens, living and dried, I have come to the conclusion that *S. decipiens* is a form distinct from *S. fragilis*, and suspect that it is a hybrid between *S. triandra* and *S. fragilis*.

Like all hybrid forms (and indeed all willows) its characters are more or less unstable; but usually it is so well marked that it is not difficult to recognize, though some leaf-specimens may be confounded with *S. fragilis* and others with *S. triandra*. In fact examples of what seems certainly to be *decipiens* were sometimes named *triandra* by the older botanists, as Forster, Borrer, &c.; and I have seen bushes and specimens which, so far as the leaves go, could not at first sight be readily distinguished from that species.

Comparing typical examples with *S. fragilis* (since it is with that species that it has been confounded), it will be found that, whereas *fragilis* attains the stature of a big tree, *decipiens* does not grow to more than a large bush or small tree—I refer, of course, to plants which have never been cut over. The bark of the trunk and older branches seems rougher and more broken than in *fragilis*, and, though not deciduous, as in *triandra*, appears inclined to split up. The branches are more upright in their direction than in *fragilis* (*i. e.* they form a more acute angle with the stem), and while somewhat brittle at their points of insertion, are less so than in *fragilis*. The year-old twigs are, as described by Smith, &c., highly polished, shining "like porcelain, as if varnished" (had Baenitz this description in view when he named his specimens var. *porcellanea*?), and most usually of a yellowish-white or clay-colour. The polish of the twigs has always been regarded as an important feature; and Smith tells Sowerby, in a note on the original sketch of his plate, to show the varnishing well, as it is the chief character. The shoots of the year are

* Some other Continental examples are simply named *S. fragilis*.

often, but by no means invariably, of a fine crimson colour (frequently on the exposed side only), but not much, if at all, polished, and, sometimes at least, longitudinally furrowed.

The leaves are constantly smaller than those of *Salix fragilis*, and while in the same specimen a good deal of variety of form may be found, they are, as a rule, more oblong, more parallel-sided (*i. e.* of nearly equal width for a greater part of their length), usually less narrowed, and often indeed rounded at the base, and more abruptly and less longly acuminate at the apex. On the whole, the leaves are broader in proportion to their length than in *fragilis*. In colour and texture there is a distinct difference, but one more readily seen than described. The upper surface is less shining and of a duller green, and the underside is pale dull green, closely reticulated all over, from the veins, even the smallest, being dark green. The secondary veins (those springing from the midrib) in the larger and broader leaves seem to form with the midrib an angle more acute than in *triandra*, and less acute than in *fragilis*. The serration is also more irregular than in *fragilis*. In the ordinary form the leaves are always glabrous (except perhaps at the very first), nor are they glaucous below; but in the forms nearer *fragilis* there are exceptions to this.

Comparing the ♂ catkins with those of *fragilis*, they will be found to be quite unlike those of the common British form, inasmuch as they are denser-flowered and have the filaments much longer than the scales. They are much more like those of the European form, but are constantly smaller, and not so thick in proportion to their length. The catkins seem to be always fewer in number on a twig than in *fragilis*, and much fewer than in *triandra*; and, so far as my observations go, the flowers are most usually diandrous, but sometimes, though more rarely, triandrous. I am not sure that any important characters lie in the peduncular leaves, which are variable and usually entire.

The ♀ plant seems to be scarcer than the ♂; and, indeed, Boswell Syme says that the ♂ only is now known in Britain, which is not, however, the case. Hoffmann describes the ovary as attenuate from an ovate base, stalked, with the style scarcely distinct; and the capsule as oblong acuminate from an ovate base. Smith says the ovary is lanceolate on a shortish stalk, and tapering into a stout style one third its own length, and that the stigmas are half as long as the style. Smith does not figure the ovary; and from Hoffmann's figure there might be said to be either no style, or else one one-third the length of the ovary so

much is it a matter of opinion where the ovary ends and the style begins. In the specimens which I have seen I cannot say that the style is so long as one-third of the ovary, while it is not very markedly different in length from the stigmas, being sometimes a little longer and sometimes a little shorter than these. In typical specimens the ovary, which is smaller than in *Salix fragilis*, with shorter style and stigmas, is ovate, tapering, but rather blunt (*i. e.* as it ripens, contracted into the style), with a rather stout style (often bifid) and rather broad spreading or recurved cloven stigmas. The pedicel is about twice the length of the inner nectary, the outer nectary being very small and obscure. In both sexes the scales are variable, but are perhaps, on the whole, less hairy than in *fragilis*, and more hairy than in *triandra*.

Though for the above comparative description typical (*i. e.* intermediate) specimens have been selected, it must be kept in mind that many examples diverge either in the direction of *fragilis* or of *triandra*, the variation being chiefly noticeable in the leaves. Thus the leaves may be distinctly glaucous below, more distinctly and persistently silky when young, and more *fragilis*-like in shape; the bark, especially of the flowering twigs, may be darker in colour than usual; and the pedicel of the ovary may be three or four times as long as the nectary.

Compared with *S. triandra*, the more polished bark of the year-old twigs, the narrower more acute stipules (when these are present), the diandrous flowers, and the usually shorter pedicel and more distinct style will generally distinguish the plant; but, from the leaves alone, I would sometimes hesitate before affirming positively whether certain specimens belonged to *decipiens* or to *triandra*.

I have described the British *decipiens* at this great length because it has, almost unanimously, been referred to *S. fragilis*, and considered not, or scarcely, worthy of the rank even of a variety. That it might really be of hybrid origin seems not to have occurred to any botanist *, though several supposed hybrids

* Mr. M. S. Bebb, the American salicologist, remarks in a letter to me:—"I have always believed that it [i. e. *S. decipiens*] was a hybrid; but this was as far as I got! With the living plant of *triandra* I am not acquainted. It will not stand the hot sun of our midsummer months, and can barely be coaxed into a sickly bush, a few feet in height, crowded with dead twigs. *S. fragilis*, on the other hand, in all its forms, fairly luxuriates in our pseudo-Asiatic climate. Now *decipiens*, sent to me by my dear old friend the Rev. J. E. Leefe as the direct descendant of the plant of Smith, exhibited, as I now remember (though the fact had for me no significance at the time), a compromise, as it were, between the vigour of *fragilis* and the arrest of growth in midsummer so marked in the case of *triandra*."

between *Salix triandra* and *S. fragilis* have been described. Kerner, for example, distinguished three forms—*S. subtriandra*, *S. alopecuroides*, and *S. Kovatsii*; but of these I have seen authentic specimens of *S. alopecuroides* only, and the descriptions of none of them fit *S. decipiens* exactly. If, therefore, it is, as I suppose, a hybrid between *fragilis* and *triandra*, it would seem to be one additional to these, which, with yet another, named *pro tempore* by Andersson *S. gracilescens*, should all be united under the oldest name, viz. *S. decipiens* *.

There is reason to believe that one of the other forms just mentioned—*S. alopecuroides*, Tausch—is also British. The Rev E. F. Linton distributed some years ago, under the name of "*Salix undulata*: Summer-flowering," a triandrous willow found near St. Neots, Hunts. The specimens I have seen are certainly, in many ways, very like *S. undulata*; but at the same time they agree so well—making a little allowance for the abnormal flowering—with Wimmer's specimens (Coll. 19, Herb. 77) of *S. speciosa*, Host (*S. alopecuroides*, Tausch), that I have little hesitation in referring them to that species. It is desirable, however, that a larger series of normal specimens should be obtained. In the locality where Mr. Linton gathered his specimens there is no sign of willow-cultivation, though some species, chiefly *S. fragilis*, grow there.

In Britain *S. decipiens* is a widely-spread, but not very abundant, plant. Some botanists think that it is perhaps always planted; but Smith was of opinion that it was truly wild, though not unfrequently cultivated. In my experience it appears to be as wild as its allies *S. triandra* and *S. fragilis*, with which it often, but not invariably, grows. Bushes of it occur which have certainly never been planted, whatever their origin may have been.

Of British illustrations of *S. decipiens*, Eng. Bot. t. 1937, and Sal. Wob. xxix., represent the ♂ fairly well; but the foliaceous glands (usually absent) at the apex of the petiole seem rather exaggerated. Smith's plate was drawn from a specimen from "Mr. Crowe's garden, May 24, 1808." Another of the original drawings is marked "Salix decipiens, I think—J. E. S.;" but the plant looks to me like *fragilis* var. b, from the catkins, the adult leaves not being shown †.

* Since this was written, I have received (through the kindness of Mr. Arthur Bennett) specimens of *S. fragilis-triandra* (Wimmer's name for *S. alopecuroides*, Tausch), cultivated in Sweden. Whilst the catkins (♂) of these are nearer *S. triandra*, the leaves &c. are quite those of *S. decipiens*.

† A botanist who does not know *decipiens* might, however, easily assume these plates to be illustrations of *S. fragilis*.

I have seen specimens of *Salix decipiens* from the following "Watsonian counties":—

3, South Devon (*Archer Briggs*); 6, Somerset (*Painter*); 12, Hants; 17, Surrey (*H. C. Watson*); 19, North Essex (*Leefe*); 23, Oxford (*Druce*); 32, Northampton (*Druce*); 36, Hereford (*A. Ley*); 38, Warwick (*T. Kirk*); 39, Stafford (*Fraser*); 64, M.W. York (*J. G. Baker*); 65, N.W. York (*Ward*); 80, Roxburgh (*Brotherston*); 81, Berwick (*Brotherston*); 85, Fife (*W. Martin*); 88, Mid Perth!; 89, East Perth!

×Salix subdola, n. hybr. (*S. triandra* × *S. alba.*)

This is an equivalent of *S. decipiens*, with the *fragilis* element replaced by *alba*. In many ways it much resembles *S. decipiens*; and leaf-specimens might readily be passed over as a form of that hybrid.

I have as yet seen the ♀ plant only with catkins, but hope that some bushes may prove to be ♂.

The ♀ forms a rather low bush with upright branches. Bark of the older twigs pale grey-brown, rather dull, that of the shoots shining yellowish, but becoming more or less brown when dried; the very youngest shoots occasionally pubescent. Buds lanceolate, yellowish, with reddish tips when alive. Leaves narrow oblong-lanceolate, tapering at the base, obliquely acuminate at the apex; margin finely and rather closely glandular-serrate, the glands blackish in colour; upper surface shining pale green, with minute white dots, the veins very slightly impressed; under surface dull, pale green or more or less glaucous; chief veins slightly raised. Leaves mostly quite glabrous, but the very youngest silky, and the petioles of the older ones and occasionally the underside of the midrib and of the lamina towards the base sometimes pubescent. Catkins about 1 inch long, narrow, cylindrical, dense-flowered, erect or erect-spreading on leafy peduncles about half their own length; rachis thick, pubescent; scales pale greenish white, oblong spathulate, apex truncate-rounded, pubescent at the base, subglabrous on the back, inner side concave glabrous, long and densely ciliate on the margin; capsule small, ovate-conic, with a pedicel a little longer than, to twice as long as, the small thick yellow inner nectary (no outer nectary); style almost none, thick, subbifid; stigmas short, half bifid, recurved-spreading, segments broad, finally brown.

The facies of this hybrid is, as mentioned above, much like that of *S. decipiens*, from which the less shining and greyer bark of the older twigs, the more slender branches, the smaller, narrower, and more finely serrate leaves, the smaller catkins, and small

capsules with much shorter pedicels—all of which indicate a connection with *Salix alba* rather than with *S. fragilis*—serve to distinguish it. Its relation to *S. triandra* is closer than to the other parent; but the structure of the scales and capsules, as well as the pubescence of the leaves, when that is present, separate it from that species.

The name *S. triandra-alba*, which might have been applied to this hybrid—if its parentage was beyond doubt,—has already been used by Wimmer for the plant generally known as *S. undulata*. The latter hybrid is, however, now usually admitted to be a hybrid of *triandra* with *viminalis*, and not with *alba* *.

I have as yet found *S. subdola* only on the west bank of the Tay below Perth.

×Salix undulata, *Ehrh.* (*S. triandra*×*S. viminalis.*)

Though for some time I believed that Wimmer, in thinking that *S. alba* and not *S. viminalis* was one of the parents of *S. undulata*, Ehrh. (=*S. lanceolata*, Sm.), was more correct than Andersson and the majority of salicologists, who hold the *viminalis* theory, I am now persuaded that Andersson's view is the right one. Wimmer, indeed, at one time considered *viminalis* to be a more probable parent than *alba*; but latterly he altered his opinion, though unfortunately he does not, in the 'Salices' at least, give his reasons for doing so.

But whilst Andersson treats *undulata* as a distinct hybrid between *triandra* and *viminalis*, he curiously gives an equally independent position to another hybrid (for which he uses Döll's name of *multiformis*) of the same two species, placing *undulata* in the *Triandræ*, and *multiformis* in the *Viminales*. Döll more correctly brings all the *triandra-viminalis* hybrids under one name; and his example I follow, using, however, the oldest name, *undulata*, instead of the latest, *multiformis*.

The forms—which have all been described as distinct species—thus brought together are *S. undulata*, Ehrh., *S. lanceolata*, Sm., *S. Trevirani*, Spr., *S. hippophaifolia*, Thuill., and *S. mollissima*, Ehrh.

Though Andersson and others adopt the view that *S. undulata*, Ehrh., and *S. lanceolata*, Sm., are identical, there is really some doubt as to what Ehrhart's species truly is. Smith says that

* Whilst the dwarf stature and general facies of the bushes incline me still to think that *S. triandra* and *S. alba* have both something to do with the parentage of this plant, more recently obtained leaves (from young shoots) strongly recall *S. fragilis*. It may be, therefore, possibly a form of *S. viridis*, though that seems to me improbable; or, perhaps, *S. decipiens*×*S. alba* (i. e. *S. fragilis*× *S. triandra*×*S. alba*).

though it is described as having a pubescent ovary, the original specimens seen by him have glabrous ovaries; and he suggests that the hairs of the scales have been mistaken for ovarian pubescence.

Wimmer thinks that under "*undulata*" several forms have been mixed up; whilst, to add to the confusion, Andersson himself, though citing under *Salix undulata, S. Trevirani,* Spreng. and the Sal. Wob. t. 13, repeats these citations under *S. multiformis*, to which—in the sense in which he uses that name—they really belong.

As generally understood, however, *undulata*, Ehrh., differs from *lanceolata,* Sm., only in having pubescent instead of glabrous ovaries, and is said to be extremely rare. From this extreme rarity and from the doubt as to whether the reputed pubescent form was really otherwise identical with *lanceolata*, Sm., I was inclined to consider the latter a hybrid, as Wimmer declares it to be, of *triandra* and *alba,* very similar indeed to the *triandra-viminalis* hybrids (*multiformis*, Döll, Anderss.), but distinguished from these by the more distinct and stronger serration of the leaves, which in vernation are revolute and not convolute. Against Wimmer's theory the only point that militated was the fact of the style of *lanceolata* being more distinct than in either *triandra* or *alba.*

My doubts on the subject have, however, been removed by the examination of a willow found in Miller's Dale, Derbyshire, by Messrs. Bailey and Painter. This has abnormal catkins, produced at the end of short branches in August. Whether the ovaries are similar to those of the spring flowers is yet uncertain *; but they differ from those of ordinary *lanceolata* only in that some of them are more or less pubescent. On the same catkin occur ovaries almost or quite glabrous, some with a little pubescence towards the top only, and others more generally pubescent, and with the pedicel also pubescent. Whilst the occurrence of these pubescent ovaries, taken in conjunction with the structure of the style, seems to afford tolerably conclusive proof that *undulata* is a hybrid of *triandra* with *viminalis,* it must yet be kept in mind that, judging from what may be seen in other Salices, too much reliance should not be put on the absence or presence of pubescence.

Taking, now, the forms which Andersson combines under *multiformis,* Döll, and Wimmer under *S. triandra-viminalis*, Wimm.,

* The Rev. W. Hunt Painter has, since this was written, kindly sent me spring flowering specimens from "this old and large tree." These have glabrous ovaries. It is desirable to see if the second flowering always shows pubescent capsules.

namely *a. Salix Trevirani*, Spreng., *b. S. hippophaifolia*, Thuill., and *c. S. mollissima*, Ehrh., it will be found that they differ from each other chiefly in the amount of pubescence of the various parts, and in the structure of the catkins and capsules, *a* and *b* being nearer *triandra*, and *c* nearer *viminalis*. (Here it may be remarked that Andersson's and Wimmer's descriptions are not in exact agreement in every particular, nor Wimmer's with his published specimens.)

Through the kindness of the Rev. Augustin Ley and Dr. Fraser, I have seen a series of a willow found by them in Herefordshire and Staffordshire respectively, distributed under the name of "*Salix hippophäefolia*, Thuill.," and doubtless the plant meant by the "*S. triandra* c. *Trevirani* (Spreng.)," of the 'London Catalogue.'*

Whilst Dr. Fraser has found, near Wolverhampton, one ♂ bush only, Mr. Ley reports that the willow found by him is tolerably common on the lower course of the Wye in Herefordshire, where it is almost uniformly androgynous, though purely male plants do occur. The specimens of the latter which he has sent to me are practically identical with Dr. Fraser's examples, except that perhaps these are a little more pubescent. Comparing them with Wimmer's specimens, I think that, although they do not quite exactly agree, yet they belong rather to *a. Trevirani* than to *b. hippophäefolia*.

Mr. Ley's androgynous examples are much more difficult to place; for though, as regards the leaves, they are perhaps nearest *Trevirani*, in catkin structure they vary a good deal, some being near *Trevirani*, and others near *mollissima*, but none of them agreeing with *hippophäefolia* as defined by Wimmer. They seem, in fact, to connect *Trevirani* and *mollissima* without touching on *hippophäefolia*, and show that *triandra-viminalis* includes more forms than those described by Wimmer or by Andersson (under *multiformis*).

In addition to the specimens mentioned above, I have seen examples of a willow collected by Mr. A. Brotherston at Carham, in Northumberland, which fits *b. hippophäefolia*. Considering that both *S. triandra* and *S. viminalis* are common British species, it seems not impossible that hybrids between them may be of more common occurrence than is at present supposed,

* It may be mentioned that both Andersson and Wimmer use "*hippophaifolia*," and some other botanists "*hippophäefolia*," to denote Thuillier's plant [Fl. Par. ed. ii. 514], and that the name *hippophaifolia* has been employed for both *a* and *b*.

though restricted by the difference in the period of flowering of the species. Leaf-specimens of the form *Trevirani* bear an evident resemblance to those of *Salix rubra*; but it is, as mentioned above, with those of the forms *undulata* and *lanceolata* that they are more likely to be confounded. Besides the difference in the serration of the leaves, as already stated, distinctions in the female inflorescence are also described; but these are not all to be relied on. The catkins are sometimes, but by no means always, smaller and slenderer, nor are the scales always darker-coloured. When the capsule is pubescent, *that* affords a ready mark of distinction from *lanceolata*; but Wimmer says that it is more usually glabrous though "*punctulato-scabra*;" the pedicel is shorter, and the style often longer and more slender. In the ♂ the stamens vary from 2 to 3.

The form *b. hippophäefolia* has much similarity to *a. Trevirani*; but makes a smaller bush, with smaller and narrower leaves, smaller and more slender catkins, and smaller pubescent capsules. The leaves of *Trevirani* are described by Wimmer as glabrous, and those of *hippophäefolia* as pubescent when young; but in his examples of *Trevirani* the young leaves, at least, show pubescence.

The form *c. mollissima* is, in its typical condition, a very different-looking plant from either *a* or *b*, and might readily be passed over as a form of *S. Smithiana* (with which, indeed, Smith at first confounded it), from the resemblance of the leaves to some states of that plant, and from the aspect of the catkins. It is, I suppose, on account of this form that Andersson has placed "*multiformis*" amongst the *Vinimales*, and not amongst the *Triandræ*. From its Continental distribution the form *mollissima* might be expected to occur in Britain, but it has apparently not yet been detected.

Though I have, in a measure, indicated the distinctions between the various recognized forms of the *triandra-viminalis* hybrid, I do not think that in it, more than in other hybrids, should varietal names be retained. Whilst the named forms, as described, seem to have a certain amount of stability, many specimens (including even those published by Wimmer himself) cannot well be placed in any of them, and though there has not yet been found such a complete series—connecting the two parents—as other hybrids afford, this is probably only on account of the rarity of the plant. Of all the forms, *lanceolata* is both the commonest and the least liable to variation; but it is doubtful whether it occurs anywhere in a

truly wild condition, especially since the ♀ only is known. Of it I have seen specimens from the following counties, in addition to those recorded in 'Top. Bot.' ed. 2:—

57, Derby (*C. Bailey*); 77, Lanark (*R. McKay*); 88, Mid Perth !; 89, East Perth !; 92, South Aberdeen (*Trail*).

Group 2. Pentandræ.

2. Salix pentandra, *L.*

Of *S. pentandra*, Andersson distinguishes three leaf-forms:—*latifolia*, with leaves whose length is two or three times the breadth; *angustifolia*, with leaves three to five times as long as broad and narrower at the base; and *microphylla*, with thin leaves scarcely more than one inch long. He remarks that *latifolia* is more usually shrubby, and *angustifolia* generally arborescent, and thinks that as the latter is the prevalent North-Lapland form, it indicates that the home of the species is in the north (Sal. Lap. p. 15).

Walker-Arnott's experience (and also mine) is that, in a wild state in Britain, *S. pentandra* is a bushy shrub; but that when cultivated it becomes a tree, with broader and larger leaves than those of the wild plant, in specimens of which from the same marsh they vary much in size and shape.

Besides the leaf-forms there is also considerable variation in the size of the catkins; but in neither case are these characters of sufficient importance to deserve varietal rank.

In Britain both the modifications *latifolia* and *angustifolia* occur, though many specimens cannot well be referred to one more than the other; but comparing British examples with Continental—of both of which I have seen a rather large series—it would seem that in Britain there is a greater tendency for the plant to be broader-leafed than in Continental Europe. Indeed, many specimens from the latter would scarcely, so far as the leaves go, be recognized, at the first glance, as *pentandra* by a British botanist.

In the Linnean Herbarium there are two sheets devoted to *S. pentandra*. On one, labelled by Linné "3. *pentandra*," the ♂ example is, without doubt, *pentandra*; but the ♀ seems a little doubtful. The other sheet bears, in Linné's writing, "*Salix pentandra*," to which Smith has put a "?," and has also a label, in a now unknown hand, "*Salix pentandra*, Flor. Lap. 370. Foliis subtus cinereis." The specimen is ♀, and seems more like *S. triandra* than anything else.

Lastly, it must be noted that Andersson describes the rhachis of

the catkin of *Salix pentandra* as glabrous; whereas other authors more correctly allude to it as hairy. It is, of course, possible that Andersson has met with specimens such as he describes.

×SALIX CUSPIDATA, *Schultz*. (*S. pentandra* × *S. fragilis*.)

In Britain this hybrid has been either overlooked or is very rare, being confined to Shropshire.

So far as the leaves go, *S. cuspidata*, says Wimmer, can scarcely be distinguished from *S. pentandra*; and this is very evident in many Continental examples, in which, from the leaves alone, it would be impossible to say to what plant they should be referred.

The most important distinction between *S. cuspidata* and *S. pentandra* lies in the ♀ catkins. In the former these are more slender and more tapering, and bear narrower and more cylindrical capsules with longer pedicels. A majority of authors describe the pedicels as three or four times the length of the nectary (as compared with *S. pentandra*, in which it is at most nearly twice the length of the nectary); but Wimmer says of the pedicel of *cuspidata* "brevissimis," and of *pentandra* "brevis;" and his specimens show a shorter pedicel in the former than in the latter. I am therefore inclined to think that *S. cuspidata*, just like other hybrids, shows an instability even in what are generally supposed to be important and constant characters, and that too much dependence must not be placed on any one point.

Apart from the female flowers, distinctions (all variable) may be found in the leaves (more acuminate, thinner, paler-veined, and sometimes glaucous below, in *cuspidata*); in the male flowers (fewer-stamened and laxer); in the scales (more hairy); in the size of the tree (bigger); and in the time of flowering (earlier than *pentandra* and later than *fragilis*). The form of the stipules is sometimes said to afford an important character; but it is very doubtful if this is the case.

Through the kindness of Mr. W. Phillips, F.L.S., I have been able to examine living specimens of the Shropshire plant. Like the British *S. pentandra*, they have broader leaves than many of the Continental examples.

Though some recent British botanists think that *S. cuspidata* is doubtfully native in its English localities, *S. pentandra* is admitted to be native as far south as Worcestershire; and as both it and *S. fragilis* occur in Shropshire, there seems to be no valid reason, on that ground, why *S. cuspidata* should not be wild there.

In answer to my inquiries, Mr. Phillips has given me the fol-

lowing information about *Salix pentandra* and *S. cuspidata* in Shropshire. *S. pentandra* seems to be native, making usually a shrub from about 7–10 feet high, but occasionally a tree of about 20 feet. *S. cuspidata* (which also appears to be native) attains in its best form a height of 25 feet or more; but another form (more *pentandra*-like) is only a shrub-like bush. Of the latter I have seen only one plant (which belongs beyond doubt to *S. cuspidata*); but bushes reported to be similar in appearance grow at comparatively short intervals for twelve miles or more along the Rea Brook. Whether these are all *cuspidata* or whether, as is probable, some, or most of them, are *pentandra*, requires investigation.

Of the Shropshire plant I have seen the ♀ only; and apparently the ♂ has not yet been detected there.

×SALIX HEXANDRA, *Ehrh.* (*S. pentandra* × *S. alba.*)

To this rare hybrid I am inclined to refer the following specimens :—

1. A plant, in the Edinburgh University Herbarium, collected near Duddingston (Edinburgh) by J. Knapp in 1836, and referred at one time to *S. alba*, and at another to *S. fragilis*. This seems most probably a hybrid between *pentandra* and *alba*, both of which grow at Duddingston.

The leaves are too young, but, on the whole, are similar to those of authentic specimens of *S. hexandra*. They are at first clothed with silky pubescence, but become quite glabrous. In some cases the apex of the petiole is glandular, but not so glandular as in Wimmer's specimens. The catkins (♀), with long leafy peduncles, much resemble those of *S. pentandra*. The capsule is more slender than in that species; and the pedicel is longer than it is, as described, in *S. hexandra*; but in a hybrid the length would be subject to variation. The style, almost obsolete, and the short spreading-erect stigmas are like those of *S. pentandra*.

2. A bush found by me at Restenet, near Forfar, growing with *S. pentandra* and *S. alba*. Of this I have not yet seen flowers; but unless to *S. hexandra*, I do not know where to refer it.

Attention may here be called to another probable hybrid of *S. pentandra* which I have found near Restenet, where that species abounds. Of this supposed hybrid I have seen leaves only. It has *somewhat* the aspect of *S. decipiens*; but since *S. triandra* does not, so far as I know, occur in that neighbourhood, it has probably no connection with the latter species. The other parent may possibly be *S. phylicifolia*.

Group 3. Fragiles.

So much confusion exists in the synonymy of *Salix fragilis* and its nearest ally, that before entering into a discussion of their forms, it will be first of all necessary to attempt to define clearly some of the essential characters of the three British plants of this group, and then to see what names they should bear. Two of these are usually admitted to be true species, and these I shall term in the mean time A and B. The third is an undoubted hybrid between them, and may be designated A × B.

A has the capsule elongate-attenuate from an ovate base, gradually produced into the style, and hence acute, distinctly pedicellate, with the pedicel 2–3 times as long as the nectary. Leaves more or less obliquely acuminate, and, though often at the very first somewhat silky, eventually quite glabrous, and shining above.

B has a smaller capsule, ovate-conic in shape, more or less obtuse at the apex, and not tapering into the very short style, scarcely pedicellate, with the pedicels at the very utmost not exceeding the nectary. Leaves usually narrower and smaller, straightly acuminate, more or less silky, rarely eventually subglabrous, and slightly shining above.

A × B, in its most intermediate condition, has a capsule larger than B, but smaller than A, conical in shape, more or less obtuse, very shortly styled, and pedicellate, with the pedicel about as long as the nectary. Leaves more or less straightly acuminate, at first somewhat silky, but eventually quite glabrous and shining above, more distinctly serrated than B, but less coarsely than A. But while this is what may be termed the typical state, innumerable forms, ranging from A to B and showing various combinations of their characteristics, occur. Some of these are with difficulty distinguished from A or from B, as the case may be.

Regarding the name that B should bear, there is no doubt, since all authors are agreed in considering it to be *S. alba*, L.; but with respect to A and A × B there is much difficulty. Delaying for a moment a consideration of Linné's description, an examination of other descriptions, figures, and authentic specimens will show that the views of salicologists regarding the names to be assigned to these two species have been widely different. The opinions of the more important writers are as follows. (The words of the author indicating which form he had in view are given within brackets and inverted commas.)

A has been called:—

Russelliana, Sm., by J. E. Smith in his *Fl. Brit.* 1045; *E. B.* t. 1808; and *Eng. Fl.* iv. 186. (*Engl. Fl.*, "germen tapering stalked.")

Russelliana, Sm., by Willdenow, *Sp. Pl.* iv. 656, n. 7 ("germinibus pedicellatis subulatis").

Russelliana, Sm., by W. J. Hooker in *Fl. Scot.* 279 (1821) ("germens pedicellate oblongo-subulate"), and in *Brit. Fl.* 4th ed., 358, n. 14 ("germens stalked lanceolato-acuminate").

Russelliana, Sm., by Forbes, *Sal. Wob.* 55, t. 28 ("germen tapering stalked," the plate showing a pedicel three times the length of the nectary).

Fragilis, L., by Koch, *Syn. Fl. Germ.* ed. 1 & 2 (ed. 2, 2. 740, n. 3) ("capsulis ex ovata basi lanceolatis pedicellatis, pedicello nectarium bis terve superante").

Fragilis, L., by Lindley, *Syn. Brit. Fl.* ed. 3. 230, n. 3.

Russelliana, Sm., by Lindley, *l. c.* 230, n. 4. (Lindley follows "the arrangement of Koch;" and though he cites the *Eng. Bot.* plates for "*fragilis*" and "*Russelliana*" respectively, he makes the capsule the same in each, and distinguishes "*Russelliana*" by the young leaves being silky and the stipules more acute.)

Fragilis, L., by Wimmer, *Sal. Eur.* 19 ("germina in pedicello brevi aut brevissimo, conico-subulata." In Wimmer's specimen, Coll. no. 9, the pedicel is about twice the length of the nectary).

Fragilis, L., by N. J. Andersson, *Mon. Sal.* 41, n. 28 ("capsulis elongato-conicis, attenuatis, pedicello nectarium bis terve superante").

Fragilis, L., by Grenier, *Fl. de France*, iii. 124 ("capsule ovoïde-conique attenuée au sommet, a pédicelle deux-trois fois plus long que les glandes").

Fragilis, L., var. β, by Walker-Arnott, in Hooker & Arnott's *Brit. Fl.* 8th ed., 401, n. 10 ("ovary lanceolate-acuminate." *S. Russelliana*, Sm., is given as a synonym of the variety).

Russelliana, Sm., by C. C. Babington, *Man. Br. Bot.* ed. 1 ("germens stalked lanceolato-acuminate").

Fragilis, L., var. *S. Russelliana*, Sm., by Babington, *l. c.* 6th, 7th, and 8th editions (with same description as in the 1st edition, and with, in the last edition, "*S viridis*, Fr. ?," as a doubtful synonym).

Viridis, Fr., by Boswell Syme in *Eng. Bot.* 3rd ed. t. 1308, as regards the plate, which is a reproduction of Smith's plate of *S. Russelliana*.

Fragilis, L., by Boswell Syme, *l. c.* viii. 205, n. 3, as regards the letterpress ("capsule conical subulate, on a stalk twice or thrice as long as the nectary").

Fragilis, L., by J. D. Hooker, *Student's Fl.*, 3rd ed. ("capsule pedicelled," which definition is rather too brief).

A × B, on the other hand, has been called :—

Fragilis, L., by Smith, *Fl. Brit.* 1051; *Eng. Bot.* t. 1807; and *Eng. Fl.* iv. 185 ("germen ovate abrupt, nearly sessile").

Fragilis, L., by Willdenow, *Sp. Pl.* iv. 669, n. 51 ("germinibus subsessilibus lanceolatis").

Pendula, Ser., by Seringe, '*Essai*,' 79.

Fragilis, L., by W. J. Hooker, *Fl. Scot.* 279 ("germens shortly pedicellate, oblongo-ovate"), and *Brit. Fl.* 4th ed. 358, n. 13 ("germens shortly pedicellate oblongo-ovate").

Fragilis, L., by Forbes, *Sal. Wob.* 53. t. 27 ("germen ovate, abrupt, nearly sessile").

Montana, Forbes, by Forbes, *l. c.* 37, t. 19 ("germens nearly sessile, ovate lanceolate").

Alba, L., γ. *viridis*, by Wahlenberg, *Fl. Suec.* ii. 635 ("tota glabra viridis." *S. viridis*, Fr., is quoted as a synonym).

Fragilis, L., var. γ. *Russelliana*, by Koch, *Syn. Fl. Germ.* 2nd ed. 741 (capsule not described; but, from the leaves, must come under A × B).

Fragilis-alba, Wimm., by Wimmer, *Sal. Europ.* 133 ("germina in pedicello brevissimo conico-cylindracea." *S. Russelliana*, Sm., *S. viridis*, Fr., and *S. pendula*, Ser., are given as synonyms).

Viridis, Fr., by N. J. Andersson, *Mon. Sal.* 43, n. 29 ("capsulis breve conicis obtusiusculis pedicellatis, pedicello nectarium subsuperante").

Fries's own description will be noticed presently.

Fragilis, L., var. *pendula*, Fr., by Grenier in *Fl. de France*, iii. 125. (From description of leaves &c., comes here. *S. Russelliana*, Sm., and *S. pendula*, Ser., are cited as synonyms.)

Fragilis, L., var. α, by Walker-Arnott in *Brit. Fl.* 8th ed. 401, n. 10 ("ovary oblong-ovate").

Fragilis, L., by C. C. Babington, *Man. Br. Bot.* 1st ed. ("germens stalked oblong-ovate").

Fragilis, var. β. *S. fragilis*, by Babington, *l. c.* 6th, 7th, and 8th eds. ("capsule oblong ovate").

Fragilis, L., by Boswell Syme, *E. B.* 3rd ed. t. 1306, as regards the plate, which is a reproduction of Smith's plate of *S. fragilis*.

Viridis, Fr., by Boswell Syme, *l. c.* viii. 207, n. 4, as regards the

letterpress (" capsule conical subulate, on a stalk slightly longer than the nectary." *Salix Russelliana*, Sm., is given as a synonym).

Other authors might be cited; but as I am unable to give the full synonymy from personal examination of the various books (so much confusion exists in the citations even of the best salicologists, that these cannot be used without having been verified), I abstain from giving more.

From the above it will be seen that A has been called:—

S. Russelliana, Sm.,
S. fragilis, L.,
S. viridis, Fr., and
S. fragilis, L., var. *Russelliana*.

And that A × B has been termed:—

S. fragilis, L.,
S. pendula, Ser.,
S. montana, Forbes,
S fragilis, L., var. *Russelliana*,
S. viridis, Fr.,
S. fragilis-alba, Wimm.,
S. fragilis, L., var. *pendula*, Fr., and
S. alba, L., var. *viridis*.

Since thus both A and A × B have been supposed to be *S. fragilis*, L., Linné's own descriptions must be referred to.

In the 'Flora Lapponica' (1737), p. 282, No. 349,—which is described thus, "Salix foliis serratis glabris ovato-lanceolatis acuminatis,"—is often quoted as referring to *S. fragilis*; but Andersson says that *S. fragilis* does not grow in Lapland, and that Linné's figure (t. viii. fig. *b*), which represents a leaf only, must be referred to *S. pentandra*, which species it is certainly very like. (In Smith's edition, 1792, there is added, after the diagnosis, "*Salix fragilis*, Sp. Pl. 1443.") In the 'Flora Suecica' (2nd ed. 1755), p. 347, n. 883, the description runs:—" SALIX (*fragilis*) foliis serratis glabris ovato-lanceolatis acuminatis; petiolis dentato-glandulosis. *Fl. lapp*. 359, t. 8. fig. B. Fl. Suec. 795. Spec. plant. 1017," which is also the description in the 'Sp. Plant.' 2nd ed. 1443.

In these descriptions nothing is said about the ovary; and, so far as the leaves go, they might equally well refer to A, A × B, or to *S. pentandra*. In fact, the plant of the 'Flora Lapponica' seems, with little doubt, to be *S. pentandra*, since Linné says

in his notes that the Lapland plant, which is a lofty bush, differs from the *tree* which grows in Sweden, which he thus describes:—"Salix foliis serratis glabris lanceolatis acuminatis appendiculatis," and quotes more especially for it Ray's (Hist. 1420), "Salix folio longo splendente, fragilis." In the 'Flora Suecica' he seems to have thought, however, that they were after all the same, as he cites the 'Fl. Lap.' and describes the leaves as "ovato-lanceolatis" instead of simply "lanceolatis." It seems, therefore, uncertain whether Linné had in view, so far as his descriptions go, A, or A × B, or both of them. Nor does his Herbarium throw any light on the subject; for the only specimen labelled "*fragilis*" by Linné has "*alba*?" added to it by Smith, and seems to be *alba* ♂.

Hudson and Lightfoot, the immediate English followers of Linné, do not afford any information by which the question can be decided; but Hoffmann (as noticed under *S. decipiens*) states that "nomine *Sal. fragilis*, L., diversæ species occurrunt," which, though it does not indicate the exact nature of the Linnean species, is valuable as showing that the subject was in an unsettled state.

Not only because he was a Swede, but a botanist of the highest rank, the descriptions of Elias Fries deserve most careful attention. By Wimmer, Andersson, and, in fact, all modern botanists, A × B has been referred to Fries's *S. viridis*, with the citation "Nov. Fl. Suec., Mant. i. p. 43," and "Nov. Fl. Suec. ed. 2, p. 283." (As a matter of fact, the name was given earlier, as Fries quotes a prior part—the first edition of the 'Novitiæ;' and it is mentioned by Wahlenberg, 'Flora Suecica,' 1826, under *S. alba*, with the citation "*S. viridis*, Fr. Nov. p. 120," while the dates of the works mentioned above are 1832 and 1828 respectively.)

As the 'Mantissa' seems to be considered the most important citation, we will first of all examine it. The part relating to the Willows is entitled "Commentatio de Salicibus Sueciæ." Here the species and forms we are now discussing are mentioned as follows:—3. *S. fragilis*, with varieties β. *S. pendula* and γ. *S. vitellina*; 4. *S. viridis*; and 5. *S. alba*.

S. fragilis is described as having the later leaves "*subsericeis*," and the capsules "*subsessilibus ovato-conicis*." It is referred to the *S. fragilis* of Linné ("in Itin. Scan. p. 200 stabilita") and of Smith. The branches are stated to arise at right angles to the trunk.

The var. β. *Salix pendula* differs by its more elongate, slender, at length pendulous branches and smaller capsules. Linné's 'Flora Suecica,' first edition, No. 812, is cited under it, and also *S. Russelliana*, Sm. "*ex spec.*" The leaves are said to be much narrower, the later ones often notably silky, and the capsules more evidently pedicellate. In both forms the catkins are described as making right angles with the branch, and the ripe ♀ catkins as pendulous.

S. viridis is said to have very glabrous leaves, and the capsules to be "*pedicellatis ovato-subulatis.*" The catkins are afterwards described as erect, and the later leaves pilose below. Fries adds that it agrees well enough with *S. decipiens* among the Smithian species.

In the second edition of the 'Novitiæ' the capsules of *S. viridis* are described as "*subpedicellatis ovato-subulatis*" and as with "*pedicello brevissimo*;" and the angles made by the branches are alluded to, viz. 90° in *S. fragilis*, 60° in *S. viridis*, and 35° in *S. alba*. As, however, this work is four years earlier than the 'Mantissa,' the description in the latter must be considered as superseding that in the former work.

In a later work, 'Flora Scanica,' 1835, *S. fragilis* is distinguished by the later leaves being silky and catkins pendulous. *S. viridis* by very glabrous leaves and erect catkins.

So far, then, as Fries's descriptions go, his *S. fragilis*, since it has subsessile and ovate-conic capsules, must belong to A × B, and his *S. viridis*, from its pedicellate and ovate-subulate capsules, to A. The leaves also indicate the same conclusion; but the description of the direction of the branches suggests the reverse. Fries's published specimens (in his 'Herbarium Normale'), so far as I have seen them, belong—*S. fragilis* to A, and *S. viridis* to A × B. From this confusion the chief deduction seems to be that Fries's views were not always the same; and that, as regards at least the essential part of the descriptions in the "Commentatio," his *S. fragilis* is the same as Smith's.

The result, therefore, which we appear to have arrived at is this:—

1st. That there is no certainty, but absolute uncertainty, regarding the species which Linné himself had in view.

2nd. That while Smith, Willdenow, &c. (and Fries in his descriptions) have considered A × B to be *S. fragilis*, L., Koch, Wimmer, Andersson, &c. have taken A to be that species.

The question is, therefore, which of these two parties is right, —a question which, it seems to me, it is almost, if not quite, impossible to decide. I am inclined to think that it is not unlikely that A × B (the Smithian *Salix fragilis*) has at least as much claim to be considered Linné's *S. fragilis* as A has. If this claim could be proved, then A would = *S. Russelliana*, Sm., and A × B would = *S. fragilis*, L.; but as there is so much uncertainty, and as an adoption of Smith's views would entail great synonymic changes, it seems more expedient to follow Koch, &c., and to consider A as being the Linnean *S. fragilis*, in which case A × B = *S. fragilis* × *S. alba*.

3. Salix fragilis, *L.*

S. fragilis, as it has just been defined, namely, with *S. viridis* as well as *S. decipiens* eliminated from it, is not, as it occurs in Britain, a species subject to any great range of variation.

The points of distinction between it and *S. decipiens* have already been pointed out, and those between it and *S. viridis* may be better considered when treating of that plant. Though in Britain, as in Continental Europe, there is no great difficulty in distinguishing it from *S. alba*, yet it is so closely allied to the latter, that, as Andersson remarks, in some regions of Asia they are united by so many forms, that it is not easy to point out the difference between them. For this reason, he thinks that possibly it originated there, and has thence immigrated into Europe. If this be the case, it must have occurred at a very early period, if Saporta is right in his determination of certain plant-remains of the Pleistocene tufa of the Seine valley, not to mention Heer's discoveries in Swiss Miocene deposits. Be that as it may, *S. fragilis* is, at the present day, in Britain as native, to all appearance, as most other species of lowland willows.

As mentioned above, *S. fragilis* does not in Britain show any great range of variation; but an examination of any extensive series and a comparison with Continental specimens will show that there are two tolerably distinct forms which seem worthy to rank as varieties. These may be called α. *genuina* and β. *britannica*; and the distinctions between them lie chiefly, if not entirely, in the flowers. In α the ♂ catkins are rather dense-flowered, with the stamens conspicuously longer than the scales, whilst in β the catkins are lax-flowered, and the stamens are scarcely longer than the scales. Hence in α the stamens and in β the scales form the conspicuous feature of the catkins. In the ♀ the differences

between α and β are not so striking, but in good specimens are sufficiently evident. In α the ovary is much wider at the base than in β; and may be described as ovate-lanceolate, that of β being lanceolate-subulate. The scales, though variable, are perhaps more usually shorter in α than in β; the catkins, especially when young, rather denser-flowered and stouter; and the styles and stigmas rather thicker. The chief difference, however, is in the shape of the ovary.

The two varieties show no constant differences in leaf-characters, though I am inclined to suspect that α is generally broader-leafed than β.

Whilst both forms occur in Britain—β, however, being very much the more abundant one—α, so far as I have seen (from specimens and figures), is the only variety found in Continental Europe. In Britain α seems to be decidedly rare. I have found one ♂ plant in Perthshire; Mr. A. Brotherston has gathered both sexes in Roxburghshire; and a ♂ collected by Mr. T. R. Archer Briggs in South Devon seems also referable to it.

Since the ♀ is Smith's *Salix Russelliana* (of which the ♀ only was known to him), perhaps β ought to retain that name as a varietal designation; but as the name "*Russelliana*" has been the subject of so much confusion, the propriety of keeping it up seems doubtful. Moreover, it is possible that Forbes's *S. monspeliensis* is the ♂ of β. Specimens received from Kew Gardens with the name *S. monspeliensis* belong to the var. β; but Forbes's figure (*Sal. Wob.* t. 30) is doubtful, as, though the single flower shows the long scale of β, the rest of the figure is more like α. The *E. B.* t. 1808, and *Sal. Wob.* t. 28, of *S. Russelliana* represent β; but in both figures the ovary is a little too obtuse at the apex—in the original drawing for the *Eng. Bot.* figure it is not obtuse. The ♂ catkins figured in the plates of "*fragilis*" in *Eng. Bot.* t. 1807, and *Sal. Wob.* t. 27, suggest β rather than α, as do the single ♂ flowers of the former, while in the latter they are like those of α. It is possible, however, that in both cases they have been taken from *S. viridis.* With the original drawing of the ♂ for *Eng. Bot.* a single catkin is preserved, which, if not *viridis*, is the var. α of *fragilis.*

Several leaf-varieties of *S. fragilis* have been described, founded on the breadth of the leaf, or on the colour of the underside; but they are not of sufficient distinctness or importance to be worthy of retention.

Finally, since in Britain *S. fragilis* has been so much confused

with *Salix viridis* and *S. decipiens*, and since it is possible that (as in several Continental localities) it may be in some places rarer than *S. viridis*, it will be necessary to work out afresh its distribution, though it probably occurs throughout. I have specimens from the following counties:—

3, S. Devon (*Archer Briggs*); 16, W. Kent (*E. Edwards*); 17, Surrey (*E. S. Marshall*); 19, N. Essex (*Leefe*); 20, Herts (*B. Daydon Jackson*); 23, Oxford (*G. C. Druce*); 27 or 28, Norfolk; 32, Northampton (*Druce*); 34, W. Gloucester (*J. M. White*); 36, Hereford (*A. Ley*); 37, Worcester (*R. F. Towndrow*); 38, Warwick (*T. Kirk*); 40, Salop (*Leighton*); 47, Montgomery (*Eyre Parker*); 57, Derby (*C. Bailey*); 64, M.W. York (*J. G. Baker*); 65, N.W. York (*Ward*); 66, Durham (*Middleton*); 80, Roxburgh (*A. Brotherston*); 83, Edinburgh (*Maughan*); 85, Fife!; 87, W. Perth!; 88 Mid Perth!; 89, E. Perth!; 90, S. Aberdeen (*Trail*).

4. Salix alba, *L.*

Although Andersson describes eleven varieties or forms (the majority, however, not being natives of Europe), and Wimmer four principal forms, *S. alba* does not in Britain present any great range of variation, with the exception of the remarkable modification *S. vitellina*.

Most of the British specimens which I have seen are in the direction of *S. cærulea*, Sm., a form which in structural differences can be separated from typical *S. alba* only by its adult leaves being less pubescent. In other respects *S. cærulea*,—probably the "Huntingdon Willow" of arboriculturists, though Smith calls "*Russelliana*" the Bedford or Huntingdon Willow,—is said to differ from ordinary *S. alba* by its more rapid growth and the greater value of its timber, and hence would be selected for planting. Thus all our trees being probably self-sown escapes when not actually planted, would most naturally belong to this form.

There seems thus to be no good grounds for retaining *cærulea* as a variety. In its extreme form the adult leaves are nearly glabrous; but between this state and the very pubescent form *argentea*, Wimm. (*S. splendens*, Bray), all gradations occur. Of the extremely pubescent form, I have seen no British examples.

As regards leaf-form, there is some degree of variation in British specimens, but not so sufficiently marked as to deserve distinction. Leefe has noticed (in Sal. Exs.) that the leaves of

the ♀ are generally broader; and, so far as I have seen, they are constantly broader in proportion to their length, and hence possibly belong to Wimmer's form *ovalis*.

Salix vitellina, L., is reduced by Koch, Wimmer, Andersson, &c. to the rank of a mere form of *S. alba*, distinguished only by the colour of its bark and its generally narrower leaves, and said to be often produced either by being cut over every year, or by a diseased condition of the plant. Whether it be a diseased condition or not, it certainly does not depend for its characters on annual lopping; and, in addition to the colour of the bark, has several important structural differences to separate it from ordinary *alba*.

The catkins are much more slender and proportionately, if not actually, longer, with usually more scattered flowers, and remarkably long and narrow scales. The leaves are smaller and usually of a paler or more yellow-green, and frequently less pubescent. Boswell Syme thinks that the ovaries are always abortive; but whilst I have not had sufficient opportunities of studying the plant to be positive, I am inclined to think that he is wrong on this point. On these grounds, I consider that *vitellina* is worthy of at least varietal rank.

Fries thought that "*S. vitellina*, L.," pertains to *S. fragilis.* In Linné's herbarium are two specimens labelled by Linné "5. *vitellina*." To the ♂ Smith has put a "?" and to the ♀ "*alba*?" The ♂ has the long scales of *vitellina*; the ♀ has short scales, but long narrow catkins; the bark in both is now purple-brown, while the leaves are too young to afford much information. On the whole, I think these specimens are nearer *vitellina* than typical *alba*.

Whether *S. alba* is native in Britain is perhaps doubtful, for, whilst usually planted, yet self-sown plants occur. The var. *vitellina* is said to occur chiefly in osier-grounds, but in Norfolk Crowe (Smith's 'Engl. Fl.') thought it was "truly wild."

× Salix viridis, *Fr.* (*S. fragilis* × *S. alba.*)

S. viridis, Fr., may be taken as the central or typical form of a Willow which presents a regular series of gradations between *S. fragilis* on the one side and *S. alba* on the other. Consequently it is considered to be a hybrid between these two species; but if, as Andersson says (as has been already noticed under *S. fragilis*), these two species are so connected in some parts of Asia that it is difficult to separate the one from the other, it seems quite pos-

sible that the plants known as *Salix fragilis* and *S. alba* may be only extreme states of one species, and that *S. viridis* is the intermediate condition. In favour of this view may be cited Hartig's statement that in N.W. Germany, where *S. fragilis* is very rare, *S. viridis* is very abundant, and Kerner's that in Lower Austria it is scarcely less common than *S. fragilis* itself.

The question of the specific identity of *S. fragilis* and *S. alba* is one, however, that must be studied in the supposed metropolis of the species in Asia, where it can alone be determined whether the connecting forms mentioned by Andersson are intermediates or hybrids. In Western Europe, into which they have immigrated or been brought, they must, in the meantime, be treated as distinct species and *S. viridis* as a hybrid between them.

In its most intermediate or typical condition *S. viridis* (or at least the ♀ plant) is not difficult to recognize, but those states (especially of the ♂) which approach one or other of the parents are by no means easy of determination.

Compared with *S. fragilis*, typical *S. viridis* has leaves of a darker green *, rather less shining, more finely serrated on the margin, and less oblique towards the apex; the ♂ catkins rather dense-flowered, narrower and longer; the ♀ catkins more (usually) erect and more slender; capsules smaller, paler when dried, conical-cylindrical, contracted into the style, and hence more or less obtuse at the apex (instead of lanceolate-subulate or ovate-lanceolate, attenuate into the style), and with a shorter pedicel not exceeding twice the length of the nectary (instead of 2–3 times as long †).

From *S. alba*, *S. viridis* differs by the broader and larger leaves, very soon quite glabrous, and more shining above; longer and less dense-flowered ♂ catkins; and larger, usually more distinctly pedicelled and distinctly styled capsules. The capsules hold an intermediate place in size between those of *fragilis* and of *alba*. Taking the average of *fragilis* capsules as 7 mm. in length, and of *alba* as 3 mm., those of *viridis* are about 5 mm.

The habit of the tree is also different from that of both its

* In his directions to the artist, noted on the original drawing for *Eng. Bot.*, Smith says, regarding *Russelliana*, "green of every part lighter than in *S. fragilis* (*i. e.* his *fragilis*, which is *viridis*), and also "the midrib is much broader in this than in *fragilis*."

† The pedicel of *fragilis*, whilst usually 2–3 times the length of the nectary, is sometimes barely twice the length, but varies in the same catkin.

parents. In *Salix fragilis* the branches (or at least the main ones) make with the stem an angle of 90°, well shown in the lower branches of the figure of "Johnson's Willow" (referred to *S. Russelliana*, Sm.) in the frontispiece of *Salictum Woburnense*. In *alba* the angle is 35°, and in *viridis* it is said to be 60°. I rather think (from measurements I have made) that the angles made by the twigs show a somewhat similar difference—those of *fragilis* forming the widest and of *alba* the narrowest angles, *viridis* being more or less intermediate. Too much dependence, however, must not be placed on this character.

Now whilst the characteristics of the typical *viridis* are as mentioned above, the hybrid, as met with, more frequently shows a departure from these towards either *fragilis* or *alba*, till finally it is almost impossible to separate it from one or other of these species. It may also have one set of organs very similar to one of its parents, and another set resembling those of the other parent. Thus the leaves and twigs may be almost inseparable from those of *alba*, whilst the capsules may be almost identical with those of *fragilis*, or *vice versâ*. It is hence almost or quite impossible to frame a short description which will include all the characters of this variable plant. In practice, however, the trained eye of a salicologist will detect differences which cannot easily be expressed in words.

S. viridis is widely distributed in Britain, occurring from Cornwall and Surrey to Perth. How it has hitherto escaped recognition is rather surprising, but is probably due to the fact of the failure of salicologists (both British and Continental) to discover that the *fragilis* of Continental botanists and Smith's *fragilis* were different plants, and the consequent confusion regarding, and erroneous determinations of, Smith's *Russelliana*. Andersson, moreover, in some quite unaccountable way, not only failed to recognize British specimens of *viridis*, but actually named them "*fragilis*," and thus led British botanists (who would place a deserved confidence in the opinion of that great salicologist) to naturally believe that *viridis* did not occur in Britain. Not to specify other instances (*e. g.* several examples in Kew herbarium*), the case of the specimens in Leefe's 'Salictum Britannicum Exs.' may be mentioned. "No. 52. *S. fragilis*, E. B. t. 1807," of which

* One instance is very curious. The more mature ♀ example on a sheet of specimens from Upsala, collected and named "*fragilis*" by Andersson, must, according to his description in the 'Monographia,' belong, beyond doubt, to *viridis*.

Leefe says, "My plant agrees well with the figure of *E. Bot.*," was examined in Watson's herbarium by Andersson, who made this note regarding it (Watson in 'Botanical Gazette,' No. 29, 1851):—"Specimina foliifera ad *S. viridem*, Fr.—amentifera ad *S. fragilem*, L., pertinent." * I have not seen the specimens in Watson's herbarium, but there seems no reason to suppose that they are different from other examples sent out under the same name and number by Leefe at the same time, and similar also to specimens published in his second fasciculus. These specimens are, beyond doubt, the *Salix fragilis* of Smith, and have an almost sessile, ovate-conic, obtuse, short-styled ovary. Andersson had not at that time written the 'Monographia;' but in it he cites, under *S. fragilis*, L., the figure in *Eng. Bot.* t. 1807, which, as is the case with Leefe's specimens, shows characters in direct opposition to his diagnosis of *fragilis*, but quite in accordance with the description of *viridis*. What adds to the unintelligibility of Andersson's note on Leefe's specimens is that the leaves of the latter do not belong to the most intermediate condition of *viridis*, but are somewhat in the direction of *fragilis*, and hence show a good knowledge of *viridis* on Andersson's part. An explanation of the mystery may be this, that, in the first place, there was time only for a hurried examination of these and the Kew specimens, and, in the second, a belief, adopted from others, and not verified by personal examination of his works, that Smith's *fragilis* was the same as the continental plant.

Both Wimmer and Andersson recognize the fact that *S. viridis* varies in the direction of one or other of its parents, but they do not describe so great a range of variation as actually exists. The modifications described by Andersson are α. *fragilior* (in the direction of *fragilis*), β. *excelsior* (the typical or most intermediate condition), and γ. *albescens* (near *S. alba*). Wimmer has also three forms—a. *viridis* (with leaves green below), b. *glabra* (leaves glaucous below), both being glabrous †; and c. *vestita*, which is the same as Andersson's *albescens*.

Nyman ('Conspectus') thinks that three varieties are of major value, viz. *S. Russelliana*, Sm., *S. excelsior*, Host, and *S. palustris*, Host. *Russelliana*, Sm., is, as has been shown, not rightly

* Andersson (*Mon.*) cites Leefe's No. 50 (*decipiens*) under *fragilis*, but does not mention Nos. 51 and 52.

† He says also "gemmis glabris," yet the autumn buds of his exemplars of *glabra* are pubescent, but seem to become glabrous by spring.

placed here, even as a synonym ; *excelsior* is, according to Wimmer, the same as his var. *glabra*, and *palustris* his var. *vestita* ; but Andersson's determination of Host's species is different.

These varieties, whatever names be adopted for them, are marked by too indefinite and inconstant characters to be of much practical value. On the whole Andersson's varietal names *fragilior* and *albescens*, if taken in the sense that they indicate a departure from the central form in the direction of *fragilis* or of *alba*, are to be preferred ; but, as mentioned above, the vegetative organs may show affinity with one, and the reproductive organs with the other, of the parents. If these names are used at all it should be with reference to leaf-structure only.

In Britain *Salix viridis* exhibits a considerable range of variety. It may be of some interest and utility to briefly notice some of the forms which I have seen.

From Worcestershire, Mr. R. F. Towndrow kindly sent me living specimens from seven trees. Two of these are so closely related to *S. alba* that if they had not formed part of the series received, I should have called them rather untypical *S. alba*. Two others are also on the *alba* side of the type or *excelsior*, which they connect with *albescens*—one being nearer the latter variety than is the other. Two others exhibit relationship to the other parent, one having leaves scarcely distinguishable from those of *S. fragilis*, and the other being much nearer the type. The remaining tree seems nearest of all to typical *S. viridis* and has leaves quite different from any of the others, and resembling those of t. 27 in Sal. Wob. and not unlike Eng. Bot. t. 1807. The catkins (♂) have the filaments apparently shorter, in proportion to the length of the scales, than in Swedish examples of *S. viridis*, suggesting a derivation from the var. *britannica* of *S. fragilis*. The broad dark green leaves recall those of *S. alba* ♀.

Of the same leaf-form as the last is a ♀ plant collected in Oxfordshire by Mr. G. C. Druce. It has long and slender catkins, and capsules resembling those of *S. alba*, but shortly pedicelled.

Very different from these specimens are a series of examples collected by Mr. T. R. Archer Briggs in South Devon and East Cornwall. They are all ♂ and, unfortunately, most of them have no adult leaves. Hence their affinity is not so easy to determine, but out of eight trees seven seem to be related to *S. alba* rather than to *S. fragilis*. Three of them are remarkable for having more or less partially triandrous, and even tetrandrous flowers, a

condition which, though probably of rare, is not of unknown occurrence. Whilst in most of Mr. Briggs's specimens the twigs are rather slender and reddish in colour, the catkins vary both in size and direction. Some of the specimens are rather like No. 1955 of Billot's 'Exsiccata,' published as *Salix fragilis*, but which agrees with the description in Grenier and Godron's 'Flore de France' of *S. fragilis* var. *pendula* (*S. pendula*, Ser.), which Wimmer says is a form of his var. *vestita* of *S. viridis*.

In Roxburghshire, Mr. A. Brotherston has found a few trees which may be described as having the leaves of *S. alba*, and the capsules, except that the pedicel is short, of *S. fragilis*. He also finds what seems to be the ♂ of the same, and I have seen a similar plant from Brandon, Warwickshire (*T. Kirk*). These would be called var. *albescens*.

In Perthshire, *S. viridis* occurs in several places on the banks of the Tay, along with *S. fragilis* and *S. alba*. In one place the trees have evidently been planted, but have almost certainly been brought from some other and adjacent part of the banks. They are all ♀ and, whilst distinctly *S. viridis*, closely approach *S. fragilis* in character. In another locality a single tree grows. This is much older than those in the above-mentioned station, and is, in all probability, self-sown. It is in many ways like *S. alba*, from which, however, the more glabrous leaves and distinctly though shortly stalked capsules at once distinguish it. From some other stations I have as yet seen leaf-examples only.

From the erroneous conceptions of Smith's *Russelliana* by many salicologists, it is not to be wondered at that the citations of descriptions and figures, as regards both *S. viridis* and *S. fragilis*, are in many cases wrong. Andersson, for example, cites *Sal. Wob.* t. 27, and Wimmer both that and t. 29 and t. 30 under *S. fragilis*, L.; but t. 27 is *viridis*, t. 29 is *decipiens*, and t. 30 is *fragilis*. Under *S. fragilis-alba* (=*viridis*, Fr.) Wimmer refers to *Sal. Wob.* t. 28 (*Russelliana*), which represents *fragilis*, and to t. 19 (*montana*), which, from the description "germens nearly sessile," as well as from the figure, is *viridis*. The references to Smith's descriptions and figures, and to those writers who have followed Smith, are likewise all wrong, though, while giving "*Russelliana*, Sm.," as a synonym of the *fragilis-alba* hybrid, both Wimmer and Andersson confessed that in their opinion the identity of *Russelliana*, Sm., was altogether doubtful. It is evident, therefore, that the synonymy and citations—both British

and Continental—of *Salix fragilis* and *S. viridis* require careful revision, since many of the existing citations have not been, it would seem, verified by personal examination of the works cited.

Both Wimmer and Andersson appear to be of opinion that *viridis* rarely, if ever, occurs otherwise than as an introduced plant. Whether this be the case in Britain, further investigations are required to show, but it is probable that it occurs spontaneously (*i. e.* self-sown) and as wild, but not more so, as either of its parents. From the nature of some of the forms it is likely that they have arisen from variations in the mode of cross-fertilization, some having sprung from *fragilis* ♂ × *alba* ♀ or *vice versâ*, and others from the crossing of *viridis* with one of its parents. Differences, too, have probably originated through one or other of the two varieties of *fragilis* being concerned in the parentage. Experiments like those conducted by Wichura are necessary to decide these questions.

S. viridis has been found in the following counties:—2, E. Cornwall (*Archer Briggs*); 3, S. Devon (*Archer Briggs*); 13, Surrey (*Winch*, *A. Bennett*); 19, N. Essex (*Leefe*); 23, Oxford (*G. C. Druce*); 29, Cambridge (*J. Holme*); 30, Bedford (*C. Abbot*); 37, Worcester (*R. F. Towndrow*); 38, Warwick (*T. Kirk*); 80, Roxburgh (*A. Brotherston*); 83, Edinburgh (*Boswell Syme*); 88, Mid Perth! Possibly also in Stafford and Derby.

B. DIANDRÆ.

Group 4. Capreæ.

This group consists of a number of very closely allied species, three of which have been found in Britain. These three—*S. cinerea*, L., *S. aurita*, L., and *S. Caprea*, L.—are the most widely distributed members of the group, occurring throughout Europe at least. Whether they are really distinct species is a disputed point, but salicologists on the whole are tolerably unanimous in retaining them as such, although it is not to be denied that, either by intermediate or hybrid forms, they are so closely connected that it is difficult to point out distinctions which will hold good in every case. Wimmer, however, is of opinion that when studied in a living state they may be separated without much trouble—an opinion for which there seems to be justification, but which does not apply to the determination of dried, and consequently

often imperfect specimens. Such examples it is often impossible to place.

Whilst the older British botanists, Smith and his followers, thought that there were in Britain five species—the three mentioned, with the addition of *Salix aquatica*, Sm., and *S. oleifolia*, Sm.—the author of the latest British Flora ('The Student's Flora') has, on account of some remarks of Andersson, reduced *S. cinerea* to the rank of a subspecies of *S. Caprea*, and suggests that *S. aurita* is probably only another form. But, though in continental Europe *S. cinerea* is not rarely, as Andersson says, to be distinguished without difficulty from some forms of *S. Caprea*, in Britain this does not seem to be usually the case, since our common form of *S. cinerea* is much more closely related to *S. aurita* than to *S. Caprea*.

From the intimate alliance between these three species, and as they flower much about the same time, they, as might be expected, readily cross with each other, and to identify the parentage of the three hybrids thus produced is often most difficult.

5. Salix cinerea, *L.*

If a series of Continental examples of *S. cinerea* be compared with a series of British specimens, it will be seen that, though, perhaps, some of the examples may be tolerably similar, there is, on the whole, an absence of exact identity between the series. Moreover, if the descriptions of the species by the Continental salicologists be studied, it will be found that they do not, in some particulars, quite fit the British plant. That this appears to be a matter of some importance may be assumed if we consider that several species, of more or less restricted distribution, have arisen either from *S. cinerea*, or from its possible progenitor *S. Caprea*, or from the same stock.

Thus, peculiar to alpine and subalpine (especially limestone) regions from France to Transylvania there is *S. grandifolia*, Ser., a species which has been confounded with *S. Caprea* and *S. cinerea*, and has even been supposed to be an alpine modification of the latter. North of the range of this species, and chiefly in alpine and mountainous districts of Silesia, occurs *S. silesiaca*, W., a species which has very great affinity and similitude to *S. cinerea*, *S. Caprea*, and *S. aurita*. Of this a subspecies is found in the Caucasus. In the Mediterranean region occurs *S. pedicellata*,

Desf., which is connected with *Salix silesiaca* by *S. grandifolia*, and has so much affinity with these that it might be considered to be a southern modification of one of them. *S. pedicellata* forms the connecting link with *S. canariensis*, C. Sm., a species very similar to it, restricted to some of the North-Atlantic islands. Besides these, certain subspecies of *S. cinerea* occur in Russia and in Persia.

From these instances it would seem that there is a tendency in *S. cinerea* and *S. Caprea* to develop local races, some of which are so sufficiently distinct as to be considered as species. Hence it would not be very surprising if in Britain an insular form should occur, and the differences between it and the Continental plant become greater by separation, since, on account of the absence of economic value in the species and its great abundance, living plants from the Continent would not likely be commonly, if at all, brought to this country.

In such closely allied Willows as the *Capreæ* the characteristic distinctions are more easily seen than described. It is thus rather difficult to put in words the differences between the Continental and the British *cinerea*, though the facies is sufficiently noticeable.

In the first place, the European plant has, as the name implies, an ashy-grey appearance, which is, in great measure, absent from the British form. This ashy-grey colour is owing to the pubescence of the twigs ("veluti incani," *Wimmer*; "griseo-tomentosi" and "incani," *Andersson*; cano-tomentosi," *Koch*; "grisâtre-tomenteux," *Grenier*) and of the underside of the leaves ("grisea," "cinerea," "de couleur cendrée"), and sometimes of the upper surface also. The British plant is, as regards the great majority of specimens, much less pubescent. The pubescence of the twigs is, moreover, not of a hoary-grey colour (except, perhaps, in the youngest shoots), but inclining rather to fuscous black; and the pubescence of the underside of the leaves has most usually a more or less considerable admixture of shining, rust-coloured, short, crisped hairs, which, with scarcely an exception (one will be noted), none of the Continental specimens show nor do the Continental descriptions mention.

In the second place, the average size of the leaves seems to be less in the British than in the Continental plant.

From this difference in the nature of the pubescence and in the size of the leaves, it follows that the British *S. cinerea* is more remote from *S. Caprea* than the Continental form, and rather nearer to *S. aurita*.

One of the European examples of *Salix cinerea* makes a nearer approach to the British form than any of the others. This belongs to the modification which occurs in Portugal, and which has been described as a species under the name *S. atrocinerea*, Brot., which Andersson treats as a synonym of *cinerea*. In the only specimen of this form which I have examined, the pubescence of the leaves (which, though thinner, are not unlike those of the British plant) is scanty and has a mixture of ferruginous hairs, but the catkins (♂) are remarkably pubescent and unlike ours. If one can judge from this single specimen, *S. atrocinerea* is worthy of more consideration than Andersson has given it.

In the catkins I have not yet detected any constant difference between the British and Continental *S. cinerea*. Andersson quotes an observation of Lange that in *cinerea* the ♂ catkins are centrifugal and in *Caprea* centripetal, and Hoffmann's illustrations of *cinerea* seem to show this. According, however, to my observations our *cinerea* has most usually centripetal inflorescence.

Without, however, a comparative study of living specimens of the Continental *cinerea*, I am unwilling to ascribe to the British form varietal or subspecific rank, though it may be that further investigations will show that it is worthy of such.

Wimmer describes one variety only (β. *spuria*, Wimm.) of *S. cinerea*. This differs solely by its narrow lanceolate leaves, and forms very like his specimens (Coll. No. 32) occur in Perthshire and elsewhere. Andersson notices three leaf-varieties—α. *latifolia*, β. *longifolia* (which includes *spuria*, Wimm.), and γ. *brevifolia*, with a subvariety *microphylla* resembling *S. aurita*. He has also a catkin-variety (δ. *laxiflora*), flowering later and with a leafy peduncle to the catkin. These leaf-varieties are useful only as indicating a considerable range of variation in the shape of the leaves, since there are all degrees of gradation between them.

As has been mentioned above, British *cinerea* seems, on the whole, to be less pubescent than the Continental plant. In a not inconsiderable number of specimens the pubescence of the year-old twigs, usually stated to be an important characteristic of the species, is almost or quite absent. Whether these specimens are true *cinerea* or hybrids it is impossible to say, since in their other characters they do not depart from *cinerea*. Frequently, too, the adult leaves are nearly glabrous.

Smith described, as has been already said, two supposed species which more modern botanists have placed as varieties or synonyms

of *Salix cinerea*. Boswell-Syme and, following him, J. D. Hooker term them and *cinerea genuina* slight varieties, which so run into each other that it is often impossible to refer a specimen to one more than to another, the distinctions being that *oleifolia* has narrower leaves with (as in *cinerea genuina*) reddish-brown hairs beneath, and *aquatica* obovate thinner leaves with usually white hairs beneath. Andersson considers them as synonyms of *S. cinerea*, *aquatica* being most probably his var. *latifolia*. Wimmer makes *S. oleifolia* a synonym, but, on account of *Sal. Wob.* t. 127 and Döll's opinion of *Eng. Bot.* t. 1437, refers *aquatica* to the hybrid *S. Caprea-cinerea*, Wimm. Walker-Arnott cannot distinguish them as well-marked varieties, and points out the fallacy of characters derived from the stipules, in whose structure Smith placed reliance. W. J. Hooker retains them as species, but states Borrer's opinion that their characters are unsatisfactory. These quotations will be sufficient to show that the general opinion is that *S. aquatica* and *S. oleifolia* are scarcely distinct, as varieties even, from *S. cinerea*, an exception being Wimmer's idea (derived from figures only) that *S. aquatica* is a hybrid between *S. cinerea* and *S. Caprea*.

One or two points in Smith's descriptions are not alluded to by modern botanists. *S. cinerea* he describes as a tree 20–30 feet high if left to its natural growth. *S. oleifolia* is also a tree; but *S. aquatica* is generally bushy, rarely forming a tree. The catkins of *S. oleifolia* are as large as those of *S. Caprea*, those of *S. aquatica* being much smaller and more like those of *S. cinerea*. He also says that *S. aquatica* is "most related" to *aurita*, and places the species in this order—*S. cinerea, S. aurita, S. aquatica, S. oleifolia*.

In Smith's herbarium specimens of both *S. aquatica* and *S. oleifolia*, from "Mr. Crowe's garden," are preserved. These are instructive in several ways, and show some discrepancies with the descriptions. The specimen of *S. aquatica* much resembles *S. aurita* in twigs and catkins; the leaves are thin, not very hairy, a little rugose above, margins slightly undulate-crenate, and underside with reddish-brown hairs. It looks like a hybrid of *S. aurita* with either *S. cinerea* or *S. Caprea*, the pubescence of the young leaves suggesting the latter. The *S. oleifolia* specimen has rather slender *aurita*-like twigs which are not very pubescent; the leaves resemble those of *cinerea*, have slightly revolute and subentire margins, and the underside has reddish-brown hairs; the catkins (♂) are larger than those of the usual *aurita*, but small for *cinerea*, and their scales are suggestive of *aurita*. With the

drawing for *Eng. Bot.* t. 1402, *Salix oleifolia*, a leaf is preserved. This, while rusty on the veins beneath, is covered below with coarse white woolly pubescence, and has the upper surface coarsely hairy; margins crenate-serrate and slightly revolute.

The specimens published by Leefe are interesting, not only as illustrating the opinion of the British botanists who succeeded Smith, but also Andersson's earlier ideas; for at the time that he examined Leefe's examples the hybrid origin of many willows had not been recognized. Leefe's specimens of the first fasciculus, taking them in their order, are these:—

"No. 38. *S. cinerea*, L., var. *β*, Koch. *S. aquatica*, Sm." From Yorkshire. Andersson thought that, as regards the leaves at least, this tended towards *S. laurina*. It is rather a puzzling plant and suggests *aurita* × *Caprea*.

"No. 39. *S. cinerea*, Sm.?" From Yorkshire. Andersson thought that this was near *S. Seringeana*, Gaud. (=*incana* × *cinerea*). So far as the specimens go it seems to me *S. cinerea* only.

"No. 40. *S. cinerea*, L., *β*, Koch. *S. aquatica*, Sm.?" From Essex. This seems to be *cinerea* × *aurita*.

"No. 41. *S. aquatica*, Sm." From Essex. A form of *cinerea*, says Andersson. This also seems to be *cinerea* × *aurita*.

"No. 42. *S. aquatica*, Sm.?" From Essex. Andersson calls it a subspecies of *S. cinerea*. To me it seems certainly a good form of *cinerea* × *aurita*.

"No. 44. *S. oleifolia*, Sm.?" From Essex. A form of *cinerea*, according to Andersson. I should call it *cinerea* × *aurita*.

In Fasciculus iv. "No. 84. *S. aquatica*, Sm.," seems to be *S. cinerea*, and "No. 103. *S. cinerea*, L., *S. aquatica*, Sm.," *cinerea* × *aurita*.

In addition to these specimens I have examined a number of others which have been distributed by various botanists and labelled *S. cinerea*, *S. aquatica*, and *S. oleifolia*, as the case may be. These, just as the above, tend to show that there exists in the minds of botanists a considerable vagueness as to how the Smithian names should be applied. As, therefore, there is now no certainty about them, it will be expedient to drop the names *aquatica*, Sm., and *oleifolia*, Sm.

6. Salix aurita, *L.*

Contrary to what is the case in the majority of British species

of *Salix*, the continental saliceologists have described more forms of *S. aurita* than British botanists have done.

Thus Andersson specifies three, and Wimmer four, principal modifications; but as these are so connected by other intermediate forms that it is often impossible to say to which a specimen should be referred, it seems unnecessary to mention them by name.

S. aurita, like its allies, is subject to a great range of variation. At the same time it can usually be recognized without much difficulty, not so much by any one characteristic as by a combination of them and its general appearance. Its closest affinity is with *S. cinerea*, and, so far as dried leaf-specimens go, it is sometimes not easy to determine to which species they belong, since certain features of the twigs and buds, described as characteristic of the species, will, in practice, be found not quite reliable. Thus the year-old twigs, which ought to be glabrous, are not unfrequently more or less slightly pubescent in *S. aurita*, and glabrous when they ought to be tomentose in *S. cinerea*; and the buds are glabrous or pubescent, though described variously as one or the other.

From this close relationship it follows that the hybrids between *S. aurita* and *S. cinerea*, when not exactly intermediate but more related to one or other of the parents, can only be distinguished with great difficulty.

× Salix lutescens, *A. Kern.* (*S. cinerea* × *S. aurita.*)

Wimmer remarks that the hybrid forms—which he calls *S. aurita-cinerea*—between *S. cinerea* and *S. aurita* are most difficult to make out, since the differences between the species themselves are not easily expressed in written notes, but that, nevertheless, such hybrids seem to be commoner than has been thought. If the student, however, has familiarized himself with the two species in question, so as to understand, in some degree at least, the range of their variation, the difficulty of recognizing the hybrid forms is not insurmountable when they occupy a more or less intermediate position. When, however, the hybrid shows, as is very frequently the case in such plants, greater affinity with one parent than the other, absolute certainty becomes well-nigh impossible.

The points of distinction between *S. cinerea* and *S. aurita* to be chiefly kept in mind are as follows:—twigs, in *aurita* more slender

and glabrous, in *cinerea* stouter and pubescent; leaves, in *aurita* smaller, softer, and more rugose; catkins, in *aurita* much smaller and with more distinct leafy bracts at the base; scales, in *aurita* narrower, more ferruginous, and less black at the tips; capsules, in *aurita* smaller, whiter, more pubescent, less subulate and more cylindrical, with no style and with short stigmas.

Theoretically the hybrid should have characters altogether intermediate, but practically it will be found that in some points the *cinerea*-influence predominates, and in others the *aurita*. The twigs are usually more slender than in *cinerea* and either pubescent or glabrous: the leaves are very variable, and from them alone it is impossible to determine the hybrid; but compared with those of *cinerea*, they are usually smaller and show, especially in a living state, more rugosity, whilst their shape and general appearance suggest a mixture with *aurita*; the catkins are intermediate in size and shape; the scales, whilst retaining a resemblance to those of *aurita*, are blacker at the tips; the capsules show an evident relationship with *aurita* in their whiter colour and more cylindrical form, whilst, in being more evidently though very shortly styled, they betray affinity with *cinerea*. In the ♂ plant reliance can be placed only in the intermediate size of the catkins and nature of the scales, taken, of course, in combination with twig- and leaf-characters.

Whilst these points indicate generally what is to be expected in the hybrid, every specimen must be judged on its own merits, and due weight allowed to certain features indescribable, but yet easily recognized by the practiced eye.

In Britain I believe that *Salix lutescens* is not an uncommon plant. Though British authors seem to have overlooked the record, Wimmer, so far back as 1866, mentions that he had seen specimens from Coventry Park, Warwickshire, collected by T. Kirk and distributed as *S. cinerea* var. *oleifolia*, Sm. This record of Wimmer's is suggestive of what turns out to be really the case, that in British herbaria *S. lutescens* has often been named *S. cinerea* or *S. oleifolia*, or even *S. aquatica*. As has been mentioned under *S. cinerea*, several of Leefe's published specimens of this group must be referred to *S. lutescens*. Some of these were issued as *S. aquatica* or *S. oleifolia*; but I think that in Fasc. i. Nos. 40, 42, and 44 (all from Essex), and in Fasc. iv. No. 103 (from Northumberland), must be called more or less good *lutescens*, as is possibly also No. 41 (of Fasc. i.). As noted

also under *Salix cinerea*, Smith's own specimens of *S. oleifolia* are possibly hybrids of *aurita* and *cinerea*, but will have to be compared with authentic examples of *lutescens*.

In Perthshire, whilst, in several places, specimens of whose hybrid origin there is no doubt, and which show several gradations, occur, I have seen a number of others about which there is much uncertainty. In places where both *S. cinerea* and *S. aurita* grow, a number of intermediate forms can be obtained, but plants of what also appears to be *S. lutescens* occur along with *S. cinerea* only. These, however, grow on the banks of rivers, and it is probable that they have been brought thither by water. Along with them grow other plants which differ very slightly from true *cinerea* and which may be (though this requires proof) hybrids of *cinerea* with *lutescens*. In the meantime I prefer to consider them as untypical *cinerea*.

I have also seen specimens of *S. lutescens* from other parts of Britain, as, *e. g.*, from Primside Bog, Roxburgh (*A. Brotherston*), Thirsk, Yorkshire (*W. L. Notcutt*), Crabtree, Devon (*Archer Briggs*)—all labelled as *cinerea*; named *oleifolia*, Sm.—Thirsk, Yorkshire (*J. G. Baker*), *lutescens* on the *cinerea* side; Quintin Pool, Warwick (*T. Kirk*), very near *aurita*; named *aquatica*, Sm.—Falkenham, Norfolk (*W. L. Notcutt*); Hatton, Warwick (*R. Bromwich*); and Dorset (*Salter*). Other specimens, which I refer to *lutescens*, are from Caithness (*E. F. Linton*), Worcestershire (*R. F. Towndrow*), Kincardineshire (*Trail*), Clova, Forfarshire, and Derbyshire (*W. R. Linton*), and Surrey (*W. H. Beeby*).

It is probable, therefore, that *S. lutescens* is a species widely distributed in Britain. At the same time it may be somewhat local, since *S. cinerea* and *S. aurita*, though not unfrequently associated, seem to prefer habitats of a rather different nature—wet moorlands in the case of *aurita* and river-banks in that of *cinerea*. Wherever the two do grow in proximity (and such places occur in many districts) there *S. lutescens* should be looked for.

7. Salix Caprea, *L.*

In the 'Monographia' Andersson described a number of forms of *S. Caprea*, most of which are not mentioned in the 'Prodromus,' nor does Wimmer name any varieties.

In Britain the species is, for a willow, so tolerably constant in its characters that it is not likely to be mistaken for any other.

At the same time it has a certain range of variation. The year-old twigs and the buds, which are normally glabrous, are not unfrequently slightly, and sometimes decidedly, pubescent; the leaves, while typically roundly-oval, vary both in size and shape, being sometimes oblong, and at others much attenuate at each end—this latter form being, perhaps, more frequently found in northern and mountainous districts; and the catkins, though usually sessile or subsessile, are not very rarely provided with a leafy peduncle. Of this latter form I have found some rather curious plants in Perthshire. These, in addition to having the rather smaller catkins (in both sexes) furnished with a conspicuously leafy peduncle, form dwarfer and more slender bushes than is usually the case with *Salix Caprea*, and are later in flowering. The leaves are, however, not dissimilar to the ordinary form of the plant, and hence are not referable to the modification or variety *S. sphacelata*, Sm.

S. sphacelata, Sm., is now considered to be a subalpine form of *S. Caprea*, though Wimmer, from the figure and description, thinks that it may be referable to *S. silesiaca*. As well as differences in the leaves, it is said to have smaller catkins than in *S. Caprea*; but, whilst for these reasons it seems to be a rather well-marked form, I have seen too few specimens to be able to come to an opinion about it. The examples in Smith's herbarium ("from Mr. E. Forster's garden") look to me somewhat like a hybrid between *S. Caprea* and *S. aurita*. So in some respects do specimens labelled "*Salix sphacelata*, Sm., Cult. Hort. Kew. J. G. Baker;" but these agree still better with Wimmer's specimens *Coll.* No. 185) of *S. Caprea-cinerea* (=*S. Reichardti*) and, at any rate, are not pure *S. Caprea*.

× Salix Reichardti, *A. Kern.* (*S. Caprea* × *S. cinerea.*)

S. Reichardti, A. Kern. (*S. Caprea-cinerea*, Wimm.), is a hybrid between *S. Caprea* and *S. cinerea*, which, according to Wimmer, is—like other hybrids of this group—very difficult to recognize on account of the close affinity of its parents.

As in Britain both *S. Caprea* and *S. cinerea* are common species, the hybrid between them might be expected to occur not rarely; but such does not seem to be the case, perhaps because their habitats are not quite identical (*Caprea* being a chiefly woodland,

and *cinerea* a river-bank species), but more especially because their periods of flowering are not exactly synchronous.

At the same time I think that the hybrid does occur, since I have seen a few specimens which, if not to it, I know not where they belong.

In Perthshire I have found several plants which, though not good intermediate forms (some leaning to *Salix Caprea* and others to *S. cinerea*), I can refer only to *S. Reichardti.* Other specimens are from Fifeshire (in Edinburgh University Herbarium), Worcestershire (*R. F. Towndrow*), and Kent (*E. S. Marshall*). A plant from Kew Gardens, labelled *S. sphacelata*, Sm., seems also to belong here; and a leaf-specimen from the "towing-path near Kew, Surrey" (*E. De Crespigny*) has leaves which are quite intermediate between *S. Caprea* and *S. cinerea.*

As Wimmer indicates, it is very difficult to point out in words the characteristics of this hybrid; and unless the student knows well the essential features of *Caprea* and *cinerea*, he will scarcely succeed in recognizing it, but rather place it as belonging to one or other of its parents, between which, of course, the combinations may be various.

On account of the plate in *Sal. Wob.* (t. 127) and Döll's opinion regarding *Eng. Bot.* t. 1437, Wimmer thinks that *S. aquatica*, Sm., is a synonym of his *S. Caprea-cinerea*; but, as pointed out under *S. cinerea*, I am inclined to believe that *aquatica* is a hybrid of *aurita* with probably *S. Caprea.*

× Salix capreola, *J. Kern.* (*S. Caprea* × *S. aurita.*)

What has been said regarding the difficulty of identifying the hybrids of *S. Caprea* with *S. cinerea*, applies with nearly equal force to the hybrids of *S. Caprea* and *S. aurita.* Like the former they, too, are not of common occurrence, since the periods of flowering of the species are not quite identical.

In a locality near Perth, where *S. Caprea*, *S. aurita*, and *S. cinerea*, as well as the hybrid between the two latter, occur together, I have found some plants which I believe are *S. capreola*, though of different forms and not quite like any of Wimmer's published specimens. One has slender branches resembling those of *S. aurita*; leaves thin, intermediate between *S. Caprea* and *S. aurita*, and not unlike the *Sal. Wob.* figure of *S. aquatica*; catkins (♀) large; capsules subulate from a broad base, with a short

style and very short erect stigmas. Though apparently a hybrid of *Salix Caprea* with *S. aurita*, it is just possible that it may be with *S. lutescens* (=*cinerea* × *aurita*)—which is common in the same locality—from certain points of resemblance which it has to *S. cinerea*. Another plant from the same place is a rather different form. The slender *aurita*-like twigs are more pubescent (in some of Wimmer's examples they are pubescent); leaves more obovate in shape, near *aurita*, but with some trace of *S. Caprea* in them; catkins (♀) near *aurita*, but with black-tipped scales; capsules distinctly styled, stigmas longer and not so constantly erect. In Worcestershire Mr. R. F. Towndrow has found, along with less well-marked forms, one bush which is a very pretty condition of *capreola*, and notable for the distinctness with which it exhibits its hybrid origin. The catkins (♀) are in facies like those of *aurita*, but the ovaries are more subulate, the style more evident though very short, and the stigmas longer; the twigs are those of *aurita*, but the leaves are nearly intermediate, leaning a little to the *Caprea* side. Still another form is presented by plants collected at Clevedon, N. Somerset, by Mr. J. W. White and labelled *S. aquatica*. Of the parentage of these there seems to be little doubt. The connection with *aurita* is shown by the slender twigs, the shape in some degree of the leaves, and very short stigmas; while from *Caprea* has been derived the larger catkins (♀), the short but distinct style, the pubescence, veining, and, to some extent, the shape of the leaves. In the ♂ plant the only catkin which I have seen (of these Somerset specimens) is nearer that of *aurita*. A willow (♀) from Trysall has narrower leaves than those just mentioned, but seems to be another form of *capreola*. In addition to these I have seen more or less satisfactory examples from Derbyshire (*W. R. Linton*), Surrey (*W. H. Beeby*), and Kent (*E. S. Marshall*).

A puzzling plant from Hurstpierpoint, Sussex (*F. A. Hanbury*), must also be referred to this hybrid. It has slender glabrous twigs, intermediate in character; leaves (rather young) also intermediate, but not distinctly recalling either *aurita* or *Caprea*; catkins (rather old) larger than *aurita*; scales of *aurita*; capsules small and shortly styled.

Still another form occurs on rocks on the west bank of the river Naver, Sutherland (*F. J. Hanbury*), which, though most probably *Salix capreola*, must, as it has no flowers, remain at present a little doubtful. The facies of the plant is that of a

small form of *Salix Caprea*; but the leaves are obovate, conspicuously stipuled, rather rugose, and not so pubescent as in *Caprea*.

Much resembling this last are specimens, also flowerless, from Glen Dole, Clova (*B. Daydon Jackson*). Their leaves are much like some of Wimmer's specimens, but in the absence of catkins it is impossible to say whether the plant is *S. capreola* or a variety of *S. Caprea*.

The probable identity of Smith's specimens of *S. aquatica* with *aurita* × *Caprea* has been already mentioned under *S. cinerea*, and I rather suspect that Leefe's No. 38 (Fasc. i. "*S. cinerea* var. *β*, Koch; *S. aquatica*, Sm."), from Yorkshire, is possibly another form. Andersson thought that in the leaves at least the relationship of this specimen was with *S. laurina* (= *Caprea* × *phylicifolia*), but from this opinion Ward (who collected the plant) strongly dissented. The plant is a very puzzling one, but, from the shape and veining of the leaves and the pubescence of the younger ones (the older being subglabrous), it may possibly be *Caprea* × *aurita*. The catkins (♂) are large and not much is to learned from them.

In continental Europe *S. capreola*, like *S. Reichardti*, is not a common species. Wimmer, who describes five forms, attributes to it a wider range of variation than does Andersson, and from its hybrid origin this it should naturally present. Like other hybrids, its characters consist in a combination of those of its parents; and as these are more or less variable, so also will be the resulting combination. Each specimen, therefore, which is supposed to belong to *S. capreola* must be judged on its own merits.

Group 5. Repentes.

8. Salix repens, *L.*

S. repens is one of the most variable, in all its parts, of European willows, and hence several species were made out of it by the earlier salicologists. These supposed species were soon reduced to the rank of varieties; but even as such they cannot be retained, since none of their characters are to be relied on. It is, of course, possible to find specimens which agree with the descriptions; but, on the other hand, many examples combine in themselves the characteristics of several forms, and cannot be satisfactorily referred to one more than to another.

As principal modifications Wimmer gives a. *argentea*, b. *fusca*,

c. *vulgaris*, and d. *rosmarinifolia*, Koch (*non* L.). Andersson, who started in the 'Monographia' with three chief forms (*repens*, *fusca*, and *arenaria*) and one subspecies (*Salix rosmarinifolia*, L.), maintains in the 'Prodromus' the latter only, and that as a variety, distinguished by its globose catkins and much longer linear leaves. It is doubtful, however, whether it deserves special mention, though in its extreme condition it is well marked. But be that as it may, the *S. rosmarinifolia* of British lists requires some notice. This made its first appearance in British books in Hudson's 'Flora Anglica,' 1762. Hudson quotes as a synonym "*Salix pumila Rhamni secundi Clusii folio, R. Syn.* 447," in citing which he is followed by Smith ('English Flora'), who, however, gives as the authority for that description "Dill. in Raii Syn. 447," and says of the plant, "Found by J. Sherard. Dill." Though Hudson gives no locality for his plant beyond "Habitat in montosis udis," it seems probable that both Hudson's and Smith's records are founded upon Sherard's specimen in the Dillenian herbarium; but Smith says that it was also "sent by Mr. Dickson, probably from Scotland, to Mr. Crowe." Since Smith's time *S. rosmarinifolia* has continued to appear in our books, as, for example, in Hooker's 'British Flora,' ed. 4, 1838, and Hooker and Arnott's 'British Flora,' ed. 8, 1860—in both of which Sherard and Dickson are recorded as the only finders; Babington's 'Manual,' ed. 8, 1881, where "S. ?" is given as the distribution; and Hooker's 'Student's Flora,' ed. 3, 1884, in which it is placed as a form of *S. repens*, "said to have been found in the last century by Sherard in bogs in Scotland," "Sherard" being evidently a slip of the pen for "Dickson." In addition to the descriptions the plant has been figured in *Eng. Bot.* t. 1365 and *Sal. Wob.* t. 87; and *Eng. Bot.* t. 1366 and *Sal. Wob.* t. 86 have been supposed to represent a variety of it. Moreover, specimens have been published by Leefe, namely *Sal. Exs.* i. No. 19, "*Salix rosmarinifolia*, L., E. B. t. 1365," "Received from Mr. Borrer many years ago, but not as a British species," and No. 24, "*Salix rosmarinifolia*, L., *S. Arbuscula*, Forbes, Sal. Wob. t. 86."

Through the kindness of Mr. G. C. Druce, I have been able to examine the willows of the Dillenian Herbarium. In it the "*Salix pumila Rhamni secundi Clusii folio*," Ray Syn. 447. n. 2, "found amongst Mr. J. Sherard's plants, the place not named," is a very bad specimen with old ♀ catkins and young leaves.

Though the leaves are rather narrower and more crowded than is usually the case, there seems to be no doubt but that the specimen belongs to *Salix viminalis*. Mr. Druce thinks that another willow in the same herbarium—the "*Salix pumila angustifolia inferne lanuginosa*" (J. Bauhin) Ray Syn. 447. 2—was also referred by Smith to *S. rosmarinifolia*. In this case the plant is *S. repens*.

As to the *S. rosmarinifolia* of Linné, salicologists differ in opinion. Andersson considered that it was the above-mentioned narrow-leaved and globose-catkined form of *S. repens*, and I am inclined to agree with him. Wimmer, on the other hand, believed it to be the hybrid between *S. repens* and *S. viminalis* (*S. viminalis-repens*, Lasch, *S. Friesiana*, And.). Wimmer referred *E. B.* t. 1365 (*S. rosmarinifolia*, "Linn.," Koch, Boswell-Syme) and *Sal. Wob.* t. 87 (*S. rosmarinifolia*, Sm.) to *S. viminalis-repens*, and by the evidence afforded by Leefe's specimens (*Sal. Exs.* i. No. 19) mentioned above, Wimmer's identification seems to be correct. The other plates, *Eng. Bot.* t. 1366 and *Sal. Wob.* t. 86 (*S. Arbuscula*, Sm. not L.), appear to represent the form *rosmarinifolia* of *S. repens*, as do Leefe's specimens No. 24, for which he quotes *Sal. Wob.* t. 86. Boswell-Syme called *Eng. Bot.* t. 1366 "*S. rosmarinifolia* var. *angustifolia*, Wulf.;" but Wulfen's *S. angustifolia* is merely a synonym of the *rosmarinifolia* form of *repens*. In Smith's herbarium the specimen labelled "*S. Arbuscula*, Fl. Brit., Mr. Crowe's Garden, 1804," seems to be the same thing. To which of the forms Dickson's plant "sent to Mr. Crowe" belonged it is now impossible to say; but I suspect that from what Forbes, W. J. Hooker, Borrer, and Walker-Arnott say regarding the close affinity of *rosmarinifolia*, Sm., and *Arbuscula*, Sm., it was probably a *repens* form.

I think that in the meantime neither *S. repens* f. *rosmarinifolia* nor *S. viminalis-repens* can be admitted to a place in the British Flora.

In Linné's herbarium an example, labelled "22 *incubacea*" by Linné himself, and, in an unknown hand, "Salix latifolia minor, C. B. 474," is a slender straight-branched *repens* with oblong straight-pointed leaves moderately pubescent below. Some authors have referred *S. incubacea*, L., to *S. repens* × *aurita*, and others to *S. repens* × *viminalis*.

It remains to be noticed that the specimens of Leefe's Sal. Exs. i. No. 11, "*S. fusca*, L., var. *parvifolia*, E. Bot. t. 1961 ?; Salict. Wob. 81," with the remark "This is remarkably devoid of the

silky pubescence characteristic of its tribe*. Received from Mr. Darwell, to whom it was sent by the late Mr. Forbes," certainly belong to *Salix Arbuscula*, L. *Sal. Wob.* t. 81 is, as regards the ♂ plant, in agreement with Leefe's specimens; but the ♀ plant figured is doubtful, and is more like *S. repens*. *Sal. Wob.* t. 80 (*S. adscendens*, Sm.) is also probably *S. Arbuscula*, L. The *Eng. Bot.* figures, however, represent *S. repens*.

Under *S. repens* must be placed, in the meantime at least, a willow in Mr. F. J. Hanbury's "Boswell herbarium" labelled "*Salix fusca*, Mullaghmore, Co. Sligo, J. B. Syme, 1840." The specimens are old and not in first-rate condition. The leaves are elliptic in shape, and hence not dissimilar to some forms of *repens*, but of a rather paler green and, almost from the first, glabrous both above and below, though some of the young leaves are densely silky and all are more or less ciliate on the entire margin. The catkins (♀) have leafy peduncles (whose leaves have buds in their axils) from ½ to 1 inch in length; the capsules are moderately hairy, pedicellate, acute, with (compared with ordinary *repens*) remarkably long and slender styles. The specimens much resemble Wimmer's specimens (*Coll.* No. 254) of *S. repens-myrtilloides*, Wimm. (*S. Aurora*, Læstad., *S. finmarchica*, Willd.), though not identical with them. Koch makes *S. finmarchica*, Willd., a variety (*ε. finmarchica*) of *S. repens*, with glabrous leaves, the young ones silky, and glabrous capsules. It is much to be desired that this plant could be rediscovered, as it deserves further study.

× SALIX AMBIGUA, *Ehrh.* (*S. repens* × *S. aurita.*)

S. ambigua, beyond doubt a hybrid of *S. repens* with *S. aurita*, is, according to Wimmer, the most frequent of all the hybrid willows.

In *Eng. Bot.* (3rd ed.) four varieties are enumerated, viz.:—*α. genuina*, *β. major*, *γ. spathulata* (Willd.), and *δ. undulata*. Wimmer mentions two forms (in addition to the more typical state), *β. microphylla* and *γ. longifolia*; and Andersson gives two modifications, 1. *S. spathulata*, Willd. (more related to *S. aurita*), and 2. *S. plicata*, Fr. (nearer *S. repens*). By Wimmer *S. spathulata*, Willd., is considered to be a synonym of *S. aurita*.

* Although, perhaps, most usually pubescent, *S. repens* is not invariably so. I have found plants quite destitute of pubescence, but which, under cultivation, became more or less hairy.

Just as in other hybrids a number of specimens will not fit the varieties defined by botanists, but present intermediate characters, so in *Salix ambigua* there is a continuous series of forms stretching from *S. aurita* to *S. repens*, and showing various degrees of combination of the characters of the two species. Hence, as it is impossible to say of all examples to which variety they should be placed, the expediency of retaining any varietal names seems doubtful.

In Britain the distribution of *S. ambigua* is not well worked out, nor does the plant seem to be thoroughly understood. Though possibly not abundant, it probably occurs wherever *S. aurita* and *S. repens* grow at all commonly together, and as these species have been found almost throughout Britain, are very frequently associated, and flower at the same time, it is likely that *S. ambigua* has a wide distribution. It can often be recognized by the leaves alone, but most easily when these are intermediate. In less intermediate forms the greater silkiness of the pubescence serves to distinguish it from *S. aurita*, and the greater rugosity of the surfaces and less silky pubescence from *S. repens*.

× Salix cinerea-repens, *Wimm.* (*S. repens* × *S. cinerea.*)

A willow found by Mr. F. J. Hanbury on sea-cliffs near Melvich, in Sutherlandshire, July 1886, has such a strong resemblance to *S. repens* that it might well be passed over as a curious variety of that species. The pubescence of the leaves is, however, different, being less silky and more crisped; the leaves are more uniformly larger, as, perhaps, are also the catkins, and thus it appears to be a hybrid of *S. repens* with one of the *Capreæ*. The smoothness of the leaves indicates that *S. aurita* is not one of the parents, and their resemblance to one specimen in Wimmer's examples (*Coll.* No. 245) of *S. cinerea-repens* suggests the probable parentage. These Melvich specimens are, however, nearer *S. repens* than most of Wimmer's. If more adult specimens as regards the leaves, and less mature as regards the catkins (♀) could be obtained, they might very probably show greater differences from *S. repens*. At the same time the plant appears to be, with little doubt, *S. cinerea-repens*, Wimm.

A specimen (in Mr. A. Bennett's herbarium) from Holme Fen, Hunts (where *cinerea* and *repens* are the "most frequent willows"), probably also belongs here, though nearer *repens*. Though

I have little doubt regarding it, yet the specimen is too poor for absolute certainty, and is mentioned merely to call attention to the probable occurrence of the hybrid.

A leaf-specimen of a willow from Clova (*W. R. Linton*) is also perhaps an example of this hybrid.

×SALIX CAPREA-REPENS, *Lasch.* (*S. repens* × *S. Caprea.*)

Very closely related to the last (and with it to *S. ambigua*, of which, indeed, Andersson is inclined to think they are both forms) is the hybrid between *S. repens* and *S. Caprea*. To it I think belong two plants found by the Messrs. Linton on the cliffs at Armadale, Sutherlandshire. Unfortunately there are no flowers on either of the specimens, and till these are seen there must remain a little doubt*. One of these specimens agrees with authentic specimens of *S. Caprea-repens* from Sweden, and is a fairly intermediate form. The other, whilst evidently belonging to the same hybrid, is, in the greater silkiness of the pubescence, rather nearer *repens*. Whilst these are undoubted hybrids of *repens*, the general facies and veining, pubescence, and colour of the leaves points to *Caprea* rather than *cinerea* or *aurita* being one of the parents, and therefore I give it a place in the list.

×SALIX NIGRICANS-REPENS, *Heidenr.* (*S. repens*×*S. nigricans.*)

Wimmer describes this hybrid from specimens sent to him by Heidenreich (who found two ♂ bushes near Tilsit, in Prussia), and compares it with *S. ambigua*. From that species it may be distinguished by the dull green of the leaves as contrasted with the grey colour of those of *S. ambigua*, which are moreover wrinkled.

Some willows found on the banks of the Tay above Dunkeld by Mr. C. M'Intosh, and on the banks of the Garry, near Blair Athole, by myself, though not very like the only specimen of Heidenreich's which I have seen, evidently belong to a hybrid between *S. repens* and *S. nigricans*.

The specimens before me include both ♂ and ♀, and show much the same characters. In all respects they are intermediate

* Since this was written I have seen a ♀ catkin grown by the Rev. W. F. Linton on a cutting of the better-marked of the two plants. This, while it has a considerable proportion of *S. repens* in it, has also part of its characters from *S. Caprea*, and tends to confirm the opinion I had already formed.

between their parents, though the leaves are suggestive of *Salix nigricans* rather than of *S. repens*. The ♂ catkins are stouter than in *repens*, but smaller than in *nigricans*, the filaments slightly hairy at the base as in the latter, and the anthers with a tendency to become fuscous after the shedding of the pollen, as in the former. The ♀ catkins are rather slender and, like the ♂, furnished with leafy peduncles; the remarkably slender young ovaries are glabrous or slightly silky towards the top, which passes gradually into the rather short style; the stigmas are short and resemble those of *repens*. The leaves in shape are not unlike some of the forms of *repens*, and are uniformly small, oval in outline, closely and finely crenate-serrate on the margin, the short tips straight or twisted, the upper surface with adpressed hairs, and the underside—especially of the younger leaves—densely covered with a silvery silk-woolly pubescence. The branches are rather flexuous, but more divaricate than is usual in *repens*, at first pubescent, afterwards glabrous and shining, and reddish- or yellowish-brown in colour.

It is possible that a hybrid between *S. repens* and *S. phylicifolia* (=*S. Schraderiana*, Willd., which is known only as a cultivated plant) also occurs in Britain; but more specimens must be seen before it can be recorded.

Group 6. PHYLICIFOLIÆ.

The British plants of this group are *S. phylicifolia*, *S. nigricans*, *S. Arbuscula*, and several hybrids of these with other willows. In discussing the group, the first point to be considered is the very difficult question of the rank as species of *S. nigricans* and *S. phylicifolia*.

All authors are agreed as to the intimate alliance of these two forms, but no recent botanist, with the exception of Bentham, has ventured to unite them, though some have expressed their doubts regarding the specific distinctness. On the contrary, they have laboured to discover points of distinction which would, at all times, serve for the determination of these willows. Unfortunately, however, for the student, these supposed distinctive characters are not always assigned to the same species, and,

moreover, they are occasionally not in accordance with the authors' own diagnoses.

In their extreme forms *Salix phylicifolia* and *S. nigricans* can be separated without any difficulty, but a by no means inconsiderable number of examples exhibit such a combination of the characteristics of each, that it is impossible to determine under which name they should be placed. It may be the case that these perplexing forms are, as some authors suppose, hybrids between two distinct species; but, in view of the polymorphic nature of both *S. phylicifolia* and *S. nigricans*, it seems more probable that they are only intermediates which connect the extremes of one most variable willow. Adopting this view, I combine them under the name of *S. phylicifolia*, L., which seems to have originally included both.

9. Salix phylicifolia, *L.*

Whilst adopting the Linnean name for the series of European species which have been made out of *S. phylicifolia*, two subspecies or major varieties, namely α. *S. phylicifolia*, L., Auct., and β. *S. nigricans*, Sm., should be distinguished.

The chief distinctions between *phylicifolia* and *nigricans* lie in the leaves and twigs. In *S. phylicifolia* the leaves are thicker and of a firmer texture, of a brighter and more shining green on the upper surface and often more glaucous below; whilst in *nigricans* they are thinner, less compact in substance, of a duller green and less shining above, and usually less brightly glaucous below—in both forms the underside may be green. *S. nigricans* has also a greater tendency to turn black in drying, but this is by no means invariable, and is of no real value as a characteristic, since some *nigricans* forms do not change colour and others appear to do so always.

The leaves of *S. phylicifolia* are not only less pubescent (sometimes, indeed, perfectly glabrous), with the pubescence quite or nearly disappearing at an earlier stage of their growth, but the hairs are usually—not always, perhaps—of a different character from those of *nigricans*. In *S. phylicifolia* the hairs are rather stouter, shorter, and straighter, somewhat shining, and, though mostly white in colour, have a mixture of bright red-brown ones. In *nigricans* the hairs, which are more numerous and sometimes

very abundant, are softer, duller-coloured, longer, more slender and less rigid, and (always?) unicolorously whitish.

As regards the twigs, the youngest—in both forms—are somewhat pubescent, but more constantly and decidedly in *Salix nigricans* than in *S. phylicifolia*; and whilst in the latter they are soon glabrous and shining, in the former they frequently remain downy and dull.

In the organs of fructification there seem to be no sufficiently constant differences.

But, as already mentioned, there are a considerable number of examples which show a greater or less combination of the characters just described. In some the affinity with *S. phylicifolia* is exhibited by the more slender, brighter-coloured, and glabrous twigs; in others it is these parts only which retain the resemblance to *S. nigricans*. In intermediate forms the twigs are usually more *phylicifolia*-like, the leaves thick and firm, shining above, but less brightly green than in *phylicifolia*, somewhat, but not very, pubescent below, and with the shining and coloured hairs of *phylicifolia* mingled with the duller and softer pubescence of *nigricans*.

Wimmer and others have considered these forms to be hybrids between *phylicifolia* and *nigricans*, and have distinguished them by the name of *S. phylicifolia-nigricans*, Wimm. It may be that Wimmer's views are correct, and that these are really hybrid forms. I am inclined, however, to think that they are only the intermediate conditions of one species; and if this is the case one name only—*S. phylicifolia*—must be retained, to the exclusion of *S. nigricans* and *S. phylicifolia-nigricans* even as varieties. But since the general concensus of opinion seems to be in favour of keeping *nigricans* as a form distinct from *phylicifolia*, it will be expedient, *in the meantime*, to distinguish by Wimmer's name, though not in his sense, the intermediate forms, and to use the designation *S. phylicifolia-nigricans* for those examples which show a combination of the characters of *phylicifolia* and *nigricans*.

Having thus indicated the characteristics of the three forms which I have united under *S. phylicifolia*, some of the British varieties which were ascribed to each when they were treated as distinct species must be noticed.

Of both *S. phylicifolia* and *S. nigricans* a considerable number of named forms—once supposed to be distinct species—are

retained in the British list. The characteristics of these consist in the shape of the leaves and in the amount of pubescence on the capsule and its stalk. An examination, however, of any considerable number of specimens will show that not only may the leaf-characters of one variety and the capsule-characters of another be present in one and the same specimen, but that both downy and glabrous capsules may occur in the same catkin. Leefe also has pointed out that under cultivation a smooth capsule may become pubescent.

Whilst there is probably no doubt that the plants on which the supposed species or varieties were originally founded showed considerable distinctness, their characters are those of individuals, and these almost all cultivated specimens. Moreover, quite different forms have not only been called by the same name by botanists who are supposed to have known the varieties, but have been figured and described. Since, then, these varieties do not exist in nature as constantly distinct entities, the varietal names can be no longer retained.

Of the varieties ascribed to *Salix phylicifolia*, one or two may be noticed more specially.

S. tetrapla, Walker, being, according to Wimmer, the same as his *S. phylicifolia-nigricans*, has been considered by some authors to be, if not a hybrid, a connecting-link between *phylicifolia* and *nigricans*. But, as Wimmer himself points out, his specimens (received from the Berlin Botanic Garden) do not agree with the English figures. Leefe's specimens (*Sal. Exs.* i. No. 8), "received from Mr. Borrer as the plant of Walker," differ from Wimmer's, and agree with *Sal. Wob.* t. 49, and appear, without doubt, to belong to *α. S. phylicifolia*. Hence Wimmer's determination (and the theories founded on it) of *S. tetrapla*, Walker, must be considered as erroneous, though his specimens seem probably referable to *S. phylicifolia-nigricans*.

S. Croweana, Sm.—It is probable that under this name two plants are confounded—one an abnormal condition of *phylicifolia*, the other a hybrid of that species with *S. purpurea*. The essential characteristic is the combination of the filaments of the stamens for a greater or less part of their length, as in *S. rubra*. But the union of stamens may originate in two ways—one normally, by hybridization with the *Salices Synandræ*; the other abnormally, by cladostemmy. In the latter the branches of the filament are said to form an obtuse angle, in the former an acute

one. From Smith's specimens, and from the drawings, the combined filaments of *Salix Croweana* form acute angles, and hence are not strictly cladostemmic as that term is defined by Wimmer. From, however, the further abnormal development (as described and figured by Forbes, t. 52, and shown by specimens published by Leefe and Ward), when the stamens become changed into imperfect ovaries, it seems probable that, as Borrer thought, the connate filaments of Smith's *Croweana* were "but an accidental monstrosity." As such most of the specimens named *Croweana* must be considered, though some plants so called are *phylicifolia* without any deformity. Besides these, however, I have seen specimens of two plants which have been referred to *Croweana*, but which apparently derive their connate filaments from the hybridization of *phylicifolia* with *purpurea*. Since, however, these specimens are imperfect—having no mature leaves—and are, besides, not of certain British origin, it is unnecessary to say more about them on the present occasion.

S. Dicksoniana.—According to Leefe, the original *Dicksoniana*, the plant described by Smith, "must be regarded as at present unknown." Leefe refers his published specimens (*Sal. Exs.* i. No. 12) "received from Mr. Borrer as from Smith" to *S. Dicksoniana*, Forbes, t. 55. fig. 1, which they seem to be. Forbes himself had doubts as to his plant being the same as Smith's, but apparently was not satisfied that it was distinct. Forbes's figure has been sometimes referred to *S. nigricans*, to which it has some resemblance in the leaves; but Wimmer points out its likeness to plants intermediate between *S. nigricans* and *S. livida*. Andersson cites *Eng. Bot.* t. 1390 under *S. phylicifolia*, but does not mention *Sal. Wob.* t. 55, except amongst the synonyms. All the specimens I have seen are cultivated ones, and probably from Borrer's plant. It is much to be desired that the form could be rediscovered in a wild state. In the meantime, judging from the cultivated examples, I strongly suspect that *S. Dicksoniana* is a hybrid between *S. phylicifolia* and *S. Arbuscula*, since in its characters it is almost intermediate between the two.

Wimmer does not distinguish by name any varieties of *S. phylicifolia*, but Andersson, in the 'Prodromus,' mentions two, which in the 'Monographia' are treated as subspecies. These are *S. Hegetschweileri*, Heer, supposed by Wimmer to be a hybrid of *S. phylicifolia* and *S. hastata*, and *S. rhætica*, Kern., which is described as a form of *S. phylicifolia* approaching *S. Arbuscula*.

It remains to be noticed that Wimmer, adopting the opinion hat the Linnean *Salix phylicifolia* is doubtful, uses the name *Weigeliana*, Willd. The specimen in the Linnean Herbarium labelled by Linné "4. *phylicifolia*," though perhaps nearer the *phylicifolia* of modern authors than it is to *S. nigricans*, is, on the whole, rather doubtful.

We must now pass on to the varieties of *β. S. nigricans*, Sm., which is one of the, if not *the*, most polymorphic of all Willows. On its modifications upwards of one hundred supposed species have been founded, eight of which are still retained, though as varieties only, in British lists. For the reasons already given, it is impossible to maintain these, though it is just possible that one or two of the mountain forms may yet be shown to have some claims to distinctness (as varieties) by their greater constancy of characters.

Judging from the specimens published by Wimmer, Kerner, Billot, Reichenbach, &c., the Continental *S. nigricans* frequently differs less from *S. phylicifolia* than does the British plant. Many of these published examples have rather slender, glabrous or nearly glabrous, shining, chestnut-coloured twigs; and are distinguished from *phylicifolia* only by the thinner leaves, if even by that. It is not wonderful, therefore, that Andersson and others have spoken of the extreme difficulty with which the two "species" can be separated.

Andersson, following Fries, gives two chief modifications of *nigricans* :—*α. borealis* (*S. borealis*, Fr.) and *β. protea* (*S. campestris*, Fr.). *S. borealis* is a big bush or small tree, with stouter branches, more downy twigs, larger leaves, and larger catkins, with a leafy peduncle. *S. protea* is a smaller bush, with thinner leaves and subsessile catkins. I have not seen authentic specimens; but, judging from the descriptions, both forms, as well as intermediates, occur in Britain. In connection with this matter, that which has been said above with regard to the nature of the British *nigricans* as compared with the published Continental examples may be kept in mind.

Wimmer mentions two varieties—*β. borealis*, Fr., and *γ. macrophylla*, Hartig (with large glabrous leaves)—and notices a number of special forms, which, however, can scarcely be identified without named examples.

γ. S. phylicifolia-nigricans.—This name (afterwards altered to

Salix nigricans-Weigeliana) is that under which Wimmer describes the plant he received as *S. tetrapla*, Walker, but which, as already mentioned, appears not to be the true *S. tetrapla*. Wimmer's plants, he thinks, were originally from Britain; and the only habitat he gives for the supposed hybrid is Scotland. Under this name I place all the specimens which cannot be referred positively to *phylicifolia* or to *nigricans*. Such examples, though less common than those which can be referred without doubt, are not rarely to be met with, and in a few places are more abundant than either *phylicifolia* or *nigricans*.

Andersson does not admit that there is any certain hybrid between *S. phylicifolia* and *S. nigricans*, and prefers to consider certain forms, which have been supposed to be hybrids, to be rather modifications of *phylicifolia* approaching *nigricans*, or of *nigricans* approaching *phylicifolia*.

The Hybrids between the Phylicifoliæ *and the* Capreæ.

Since in many parts of Britain species of the *Phylicifoliæ* and *Capreæ* groups frequently grow together, and their periods of flowering overlap, hybrid forms occasionally occur. It is not usually difficult to recognize these as hybrids, but it is not always easy to determine the exact parentage.

Having reduced *S. nigricans* and *S. phylicifolia* to the rank of subspecies or major varieties of one willow, the number of the hybrid forms ought perhaps to be likewise reduced; but since the *nigricans*, or the *phylicifolia*, element in the compound is often distinctly marked, it seems expedient to keep their hybrids separate.

In their most intermediate forms the hybrids of this group show such a combination of the characters of their parents that their compound origin is at once evident; but, as usual, there are other forms which are not so easily recognized and are still more difficult to describe. The most certain character perhaps is in the structure of the style and stigmas—smaller than in the *Phylicifoliæ*, and larger than in the *Capreæ*; but there are also usually other good characters in the catkins and in the leaves.

Whilst in most cases, though by no means in all, it is possible to decide whether it is *nigricans* or *phylicifolia* that is one of the parents, there is often a very considerable difficulty in determining which of the *Capreæ* is the other, and more especially in those forms where the latter element is the less predominant one.

Consequently the proper position of a number of specimens must remain doubtful.

That *Salix nigricans* hybridizes with *Caprea* and *cinerea* is admitted by all salicologists; but hybrids with *aurita* have been denied by some, though it seems certain that they exist. Since, then, *nigricans* crosses with these three *Capreæ*, it seems but reasonable to suppose that *phylicifolia* should form analogous hybrids. Salicologists, however, allow only one such compound namely with *Caprea*. There occur in Britain, however, some willows which seem to show more or less distinctly the hybridization of *phylicifolia* with *cinerea* and *aurita*.

×Salix laurina, *Sm.* (*S. phylicifolia* × *S. Caprea.*)

×Salix Wardiana (*Leefe, MS.*), n. hybr. (*S. phylicifolia* × *S. cinerea.*)

×Salix ludificans, n. hybr. (*S. phylicifolia* × *S. aurita.*)

×Salix tephrocarpa, *Wimm.* (*S. phylicifolia* × *S. cinerea* × *S. Caprea.*)

×*Salix laurina.*

Regarding the position and limits of *S. laurina*, there has been much disparity of opinion. Whilst Borrer and W. J. Hooker thought that it was very distinct, Walker-Arnott was inclined to believe that it connects *S. nigricans* and *S. phylicifolia*, and that *S. tenuior*, Borr., and *S. tenuifolia*, Sm., were synonyms and varieties of it. Leefe thought that it could not be satisfactorily distinguished from *S. phylicifolia*, of which species Babington considers it as a variety. Boswell-Syme gives it as intermediate, and J. D. Hooker as a hybrid between *S. phylicifolia* and *S. Caprea.*

Andersson and Wimmer, on the other hand, have no doubt that it is a hybrid between *phylicifolia* and *Caprea*; though Wimmer says that, on account of the uniformity of the specimens which he had seen from various parts of Continental Europe, it is a question whether it should not be considered to be a distinct species, and not a hybrid. This constancy of form, he thinks, is due, however, to the fact that probably all the specimens have been cultivated from an English stock. I have seen too few European examples to venture to endorse Wimmer's opinion; but the British plants which have been referred to *S. laurina* are by no means uniform in their characters; and to this is probably due the differences of opinion amongst British botanists. This

absence of uniformity, moreover, arises from the fact that two, if not three, different hybrids have been confounded under the name of *Salix laurina*, Sm.

Adopting Andersson's view that *S. laurina*, Sm., is a hybrid between *phylicifolia* and *Caprea*, the figure in *Eng. Bot.* t. 1806, the description in the third edition of that work, and the specimens published by Wimmer (*Coll.* no. 90) and Reichenbach (no. 2417) may be cited as illustrating the characters of the species*. In most respects it very greatly resembles *S. phylicifolia* (with which, Andersson says, it has often been confounded), but shows its relationship to *S. Caprea*, not only in the structure of the ♀ catkins (the ♂ is unknown), but in the subarborescent growth, and in the size (and pubescence when it is present) of the leaves.

From the resemblance of the leaves, *S. laxiflora*, Borr., has been referred to *S. laurina* (as, *e. g.*, in the 'Student's Flora,' and, with some doubt, by Andersson); and it is possible that it may be a state much nearer *S. phylicifolia*, though from the structure of the flowers it is more probably a form only of that species.

× *Salix Wardiana*.

In addition to plants which agree with *S. laurina*, Sm., as indicated above, others have been published which, while evidently closely related to them, seem to show affinity with *S. cinerea* rather than with *S. Caprea*.

Amongst these are several published by Leefe, including that "received from Mr. Borrer many years ago as the plant of Smith" (Fasc. ii. No. 38), as well as the following:—

Sal. Brit. No. 43, found near Richmond, Yorkshire, by Ward, and labelled "I should refer it to *aquatica*. Borrer." Of this Andersson said "Mihi *S. laurinæ* forma;" and Leefe and Ward thought this a better verdict than Borrer's. The same plant was published in *Sal. Exs.* iii. No. 60, as *S. phylicifolia*, "*S. laurinæ*, Sm., proxima," with the remark that, though desiring to call it after the dis-

* *Eng. Bot.* t. 1806 is cited by Smith under *S. bicolor*, Ehrh. (of which he makes *S. laurina* a synonym); but *S. bicolor*, Ehrh., is only *S. phylicifolia*. *S. bicolor*, Forbes, t. 38, though it has Smith's description of his *bicolor* (*laurina*) appended, seems to be a different plant; and Wimmer thinks that it represents *phylicifolia*, though the style is rather short.

coverer, Mr. Ward, he (Leefe) feared that it could not be satisfactorily distinguished from *Salix laurina.* Specimens seem also to have been afterwards distributed with the MS. name "*S. Wardiana.*"

Sal. Exs. i. "No. 3. *S. laurina,* Sm.," "sent me under the name of *S. myricoides.*"

Sal. Exs. iii. "No. 62. *S. phylicifolia.*" "*S. laurinæ,* Sm., proxima." "This connects No. 60 with *S. laurina,* Sm., No. 38, and *S. myricoides,* No. 3." *

That these specimens have a similarity to each other may be gathered from Leefe's remark on the last (*Sal. Exs.* iii. No. 62), and that they also bear resemblance to *S. cinerea,* Borrer's note on No. 43 suggestively indicates; though how that acute salicologist could refer the catkins to that species is rather puzzling.

Leefe's specimens are all much nearer to *S. phylicifolia* than to *S. cinerea*; but in Perthshire I have found several willows which complete the transition from one species to the other; and it is probable that a search in the localities whence Leefe's specimens came would reveal similar intermediate forms. The Perthshire specimens show much greater resemblance to *cinerea* than to *phylicifolia*; but that they are hybrids of *cinerea* with one of the *Phylicifoliæ* is demonstrated by the evident style, while the general glabrosity of the twigs, and to some extent of the leaves, indicates that *phylicifolia* rather than *nigricans* is the parent.

Compared with the true *S. laurina,* this hybrid may be distinguished by its smaller catkins and smaller leaves, the general appearance and shape of which are suggestive of *cinerea.* The pubescence of the underside of the leaves shows a combination of the characters of the hairs of *phylicifolia* and *cinerea* without the soft woolliness of that of *Caprea.* The capsules, which are somewhat variable, show no very great points of distinction, though usually smaller and without the yellowish whiteness frequently exhibited by the *Caprea* hybrid.

For the hybrid between *S. phylicifolia* and *S. cinerea* I have adopted Leefe's MS. name, *S. Wardiana,* since it commemorates a botanist who was a diligent and sagacious student of British

* Besides these, Leefe published another, *Sal. Brit. Exs.* "No. 73, *S. laurina,* Sm.," found at Richmond, Yorkshire, by Ward. Of this, Andersson says that it recedes somewhat from the true *S. laurina,* but is nevertheless near it. If it is *laurina* at all, it is very near *phylicifolia,* and I would rather refer the specimens I have seen to that species.

Willows. The name *Salix Wardiana* is, of course, used in a wider sense than that in which it was employed by Leefe.

The ♂ has not been noticed, and though it probably occurs, it is very possibly difficult to recognize.

× *Salix ludificans.*

In addition to the Willows just noticed, I have seen specimens from a few bushes, which, whilst undoubtedly very close to *S. phylicifolia*, cannot be satisfactorily referred to that species, on account of their short styles and other peculiarities, which seem to indicate that they are of hybrid origin. The *phylicifolia* element in them is so predominating that it is difficult to determine the other parent, but after considerable study I think it must be *S. aurita*. Since *S. aurita* flowers a little later than the other *Capreæ*, it might be imagined that hybrids of it with the *Phylicifoliæ* would be at least as frequent as those of the other *Capreæ*; but this is either not the case, or they have been overlooked.

For this hybrid I propose the name *S. ludificans*. As already indicated, all the specimens I have seen are very much nearer *phylicifolia* than *aurita*, though, judging from other hybrids, it is probable that forms more remote from *phylicifolia* occur.

The specimens and some of their distinguishing characteristics are as follows:—

A bush found by Mr. C. M'Intosh on the banks of the Tay above Dunkeld has the catkins (♀) quite intermediate between *phylicifolia* and *aurita*; but the leaves are very near those of the former species, exhibiting, however, in their shape a suggestion of *aurita*. The scanty pubescence, moreover (present on some of the leaves only), shows an affinity with *aurita*, since the hairs are finer and softer than in *phylicifolia* and slightly crisped.

The other specimens I have seen were collected in Caithness by Mr. J. Grant and sent to me by Mr. A. Bennett. The examples are, unfortunately, not in the best condition and the material is scanty. They represent three bushes, of which one is ♂ and two ♀. One has the catkins (♀) rather different from the above-mentioned Perthshire plant, but, like it, intermediate between its supposed parents, and has the young leaves (I have not seen mature ones) apparently also intermediate. Another bears a striking resemblance to some forms of the hybrid between

Salix aurita and *S. nigricans*, but with the *nigricans* element replaced by *phylicifolia*, and, though a different looking plant from either of the above, shows its hybrid nature in all its parts.

The ♂, though, like the others, near *phylicifolia*, yet shows, in the small catkins and structure of the leaves, a relationship with *aurita*; but if it had not been for the ♀ examples it would probably have been referred to *phylicifolia*.

× *Salix tephrocarpa.*

In connection with the hybrids of *cinerea* and *phylicifolia*, mention must be made of the Willow described by Wimmer under the name *S. tephrocarpa*. Of this one bush only seems to be known, and, though it grows in the Berlin Botanic Garden, its origin is quite uncertain.

Both Wichura and Wimmer tried in vain to ascertain the parentage of this plant, and the latter finally came to the conclusion that it might be a hybrid between *laurina* and *cinerea*.

A Willow found by Mr. C. M'Intosh on the banks of the Tay, above Dunkeld, agrees pretty well with the description of *S. tephrocarpa*; but I have been able to compare the leaves only, which I owe to the kindness of Herr Hennings, Director of the Berlin Botanic Garden.

The Berlin and Dunkeld leaf-examples, though not identical, have a fair resemblance to each other, and both show an undoubted relationship with *cinerea*. In other respects the Dunkeld plant has some affinity with *Caprea* and, to a slight degree, with *phylicifolia*. The catkins (♀) are large and very handsome, the white capsules contrasting strongly with the conspicuously black scales. The style is very short but present; and in this and some other points the affinity with *phylicifolia* is shown.

In the meantime I can find no place for this form but as a hybrid between *cinerea*, *Caprea*, and *phylicifolia*, and possibly arising from *cinerea* × *phylicifolia* crossing with *Caprea*.

× Salix latifolia, *Forbes*. (*S. nigricans* × *S. Caprea*.)

Wimmer and, on his authority, Andersson consider that *S. latifolia*, Forbes, t. 118, is a hybrid between *S. nigricans* and *S. Caprea*. Leefe, on the other hand, has published (*Sal. Exs.* ii.

Nos. 52 & 53), under that name and with citation of the plate, a plant which he says is only a form of *Salix nigricans*.

Comparing Leefe's specimens with Forbes's plate and description, I find that they do not agree, and that whilst Leefe's *latifolia* is nothing more than what he thought it to be, i. e. *nigricans*, Forbes's plant is evidently a hybrid form.

From the affinity between *S. Caprea* and *S. cinerea*, their hybrids with *S. nigricans* frequently so much resemble each other that it is not easy to separate them. Wimmer relies on the yellowish-white much thicker capsules, thicker, shorter and broader catkins, the much broader, oval-subrotund young leaves, and the larger, broader, and more hairy old leaves, as characters by which to distinguish the best form of *latifolia* from hybrids of *cinerea* with *nigricans*, but remarks that some specimens show a departure from these points of distinction.

S. latifolia seems to have been found in a very few places in Lapland, Sweden, and Germany. The only undoubted specimens I have seen are all * from Perthshire, where three bushes—in two widely separated localities—have been found by Mr. C. M'Intosh and myself.

Of these, one is quite intermediate between *S. Caprea* and *S. nigricans*; another greatly resembles *Sal. Wob.* t. 118 and has more affinity with the *cinerea-nigricans* hybrid, but also seems to be, beyond doubt, *latifolia*; and the third, in its longer styles, inclines more to *nigricans*.

Of *S. latifolia* the ♀ only was known to Forbes and to Wimmer, but Andersson describes the ♂.

Wimmer refers *S. firma*, Forbes, t. 106, and *S. cotinifolia*, Sm., Forbes, t. 114, with some doubt, to *S. latifolia*; but Andersson thinks that they represent *nigricans* only. Of *S. firma* I have seen specimens from Kew Gardens which, though not quite identical with the plant figured by Forbes, are probably the same: they possibly represent another form of *latifolia*, but I think are rather *cinerea* × *nigricans*. The plant usually called in Britain *cotinifolia* does not appear to be the same as Forbes's, and is only *nigricans*.

* Since this was written I have found in Edinb. Univ. Herbarium a specimen labelled "S.W. corner of Duddingston Loch," which must be referred to *S. latifolia* ♀.

×SALIX STREPIDA (*Schleich.*), *Forbes.* (*S. nigricans* × *S. cinerea.*)

Andersson uses the name *S. puberula,* Döll, for the hybrid formed by *S. cinerea* with *S. nigricans,* because he and Wimmer think that *S. vaudensis* (Schleich.), Forbes, is, though probably the same thing, somewhat doubtful. Wimmer is also of opinion that *S. strepida* (Schleich.), Forbes, t. 100, bears more resemblance to the same hybrid than to anything else, though Andersson refers it to *S. nigricans.*

Of *S. strepida* I have received specimens from Kew Gardens which are sufficiently like Forbes's figure, and which seem, without doubt, a hybrid between *cinerea* and *nigricans.* Consequently, since the name is earlier than either *vaudensis* or *puberula,* I have adopted it for this hybrid. *S. firma,* Forbes, t. 106 (which Wimmer thinks may be *S. Caprea-nigricans*), and *S. vaudensis,* Forbes, t. 117, are, judging from specimens cultivated at Kew, forms of the same hybrid.

Like other compound willows, *S. strepida* is subject to considerable variation, increased in this case by the variability of its parents. In addition to this, the intimate alliance, on the one hand, of *nigricans* to *phylicifolia,* and, on the other, of *Caprea* and *aurita* to *cinerea,* augments the difficulty of satisfactorily placing every specimen, and makes it impossible to draft such a description as will serve to identify the hybrid in every case. At the same time *S. strepida,* in many of its forms, has a facies of its own which, when once learned, should not fail to guide the student to a correct discrimination of the species.

Wimmer and, following him, Andersson describe three forms— *α. puberula* (Döll), *β. vaudensis* (Forbes), and *γ. nitida,* Wimm. From the examination of a number of specimens, I am unable to see any sufficient reason for maintaining these varietal names.

In its best forms, *strepida* combines the characters of its parents, but not unfrequently it exhibits more relationship with one than with the other. In some of its states the leaves so much resemble those of *nigricans,* that it is only by the shorter style and stigmas that any connection with *cinerea* can be suspected. In others the leaves, catkins, and capsules are so like those of *cinerea* that the relation with *nigricans* (or perchance with *phylicifolia*) is shown only by the rather long styles.

In Continental Europe *S. strepida* has been recorded from a

very few places only, perhaps because it has not been carefully looked for. In Britain it may not unreasonably be expected to occur in those parts of the north where its parents grow together, as they often do, since in Perthshire it is of wide, though not of abundant, occurrence on the banks of the Tay and some of its tributary streams. I have found both sexes, but have seen more ♀ than ♂ plants, probably because the former are more easily recognized. In the south-east of Scotland Mr. A. Brotherston has found plants which probably belong to *Salix strepida*, though the material I have seen is scarcely sufficient for absolute certainty.

× SALIX CORIACEA (*Schleich.*), *Forbes*. (*S. nigricans* × *S. aurita*.)

In his notes on *S. cinerea-nigricans* (*S. strepida*), Wimmer says that it is hardly to be doubted that hybrids between *S. nigricans* and *S. aurita* occur. As examples of such he cites *S. conformis*, Schleich., in Herb. Willdenow, and thinks that Forbes's figure, t. 119, of *S. grisophylla* (Schleich.), Forbes, also represents such a hybrid.

Andersson, after quoting Wimmer's words, says that the *S. conformis* referred to is represented by three specimens, of which two belong to *S. aurita* and the third to *S. cinerea*, and that the specimens of *S. grisophylla*, published by Schleicher, which he has seen, are, as regards some, *S. nigricans*, and, as regards others, *S. cinerea*.

Under the name *S. aurita-nigricans*, Heidenr., Heidenreich has distributed specimens of a Willow found near Tilsit in Prussia; but I am not aware that any description of it has been published.

Here and there, on the banks of the Tay between Dunkeld and Logierait, Mr. C. M'Intosh and I have found plants which appear to be certainly a hybrid between *S. nigricans* and *S. aurita*. As might be expected, these bear a very considerable resemblance to *S. strepida*, and some of them, indeed, might be nearly as well referred to that hybrid, except for a certain appearance suggestive of *aurita* rather than *cinerea*. Others, however, show a distinct combination of the characters of *aurita* and *nigricans*, and agree tolerably well with Heidenreich's examples.

Though Wimmer refers it to *S. nigricans*, I think that Forbes's

t. 112, *Salix coriacea*, represents this hybrid. From the plate alone no certain conclusion could be derived; but specimens received from Kew Gardens, and others published by Leefe (under *S. nigricans*), can scarcely be satisfactorily placed otherwise than here, though they do not exhibit the best form of the hybrid. In the plate both ♂ and ♀ flowers are shown, but I have seen the ♀ only. The flowers in the specimens show a more marked relationship with *aurita* than they do in the plate. If I am right in referring Forbes's plant, *S. coriacea* (Schleich.), Forbes, must be the name of the hybrid; otherwise it will have to be called *S. aurita-nigricans*, Heidenr.

Like its close ally *S. strepida*, *S. coriacea* shows considerable variation. From that species the form of the leaves, recalling *aurita* rather than *cinerea*, the usually smaller and narrower ♀ catkins, the shape and smaller size of the capsules, and frequently the colour of the scales are characteristic points which will serve to distinguish *coriacea*. So far, however, as our specimens go, it is more likely to be passed over as a form of *nigricans*, from which, however, careful examination will show its distinctness.

A plant found on the banks of the Tay above Dunkeld by Mr. C. M'Intosh must be noticed here, since it seems to include *nigricans* and *aurita* amongst its parents. From certain points, however, in which it resembles the willow (from the same locality) already referred to as *S. tephrocarpa*, Wimm., I am inclined to suspect that it also includes *S. Caprea* and is a hybrid of that species with *S. coriacea*.

10. Salix Arbuscula, *L.*

There is a divergence of opinion amongst botanists as to the situation of *S. Arbuscula*. Many, including the British, think that it should be associated with *S. Myrsinites*, &c.; but Andersson, on account of the great similarity of the dwarfer forms of *S. phylicifolia* and the larger sub-alpine states of *S. Arbuscula*, considers that its place is amongst the *Phylicifoliæ*.

A number of varieties or modifications have been described, but various authors have treated these differently.

The varieties of the 'London Catalogue' are:—a. *carinata*, Sm., b. *fœtida*, Schleich. (=*prunifolia*, Sm.), c. *venulosa*, Sm., and

d. *vaccinifolia*, Walker—all of which were at one time supposed to be distinct species.

Wimmer has:—*α. Waldsteiniana*, Willd., *β. formosa*, Willd., and *γ. fœtida*, Schleich. (to which he refers *venulosa* and *vaccinifolia*).

Andersson has also three chief modifications—*α. erecta* (with three leaf-forms which include *Waldsteiniana*, *formosa*, and *prunifolia*); *β. humilis* (with two leaf-forms which include *fœtida*, *venulosa*, and *vaccinifolia*); and *γ. thymelæoides*, Schleich. (about which Wimmer is doubtful, and which Andersson thinks may be a subpilose condition). Both Wimmer and Andersson place *Salix carinata*, Sm., as a synonym of *S. Arbuscula.*

If any varieties are to be retained, Andersson's arrangement seems to be the best. *S. erecta* is distinguished by its more upright and taller growth, its larger leaves, and less leafy catkins; *humilis* by its smaller size, more creeping habit, smaller leaves, and by the catkins which, when young, are subglobose and buried in leaves.

But whilst plants occur which agree well with the definition of one or other of these modifications, there are many which cannot be placed in one more than in the other. I therefore think that it is inexpedient to adopt any varietal names. As for the British forms, there seems to be little doubt but that Walker-Arnott is right in saying that they cannot be satisfactorily distinguished.

There are some discrepancies in the various descriptions of *S. Arbuscula.* By some authors the style is described as elongate or long; by others as very short or mediocre, which in the majority of cases it is. The capsule is sometimes said to be sessile, whereas it has a pedicel of varying length but always much shorter than the rather elongate nectary, a character which distinguishes it from *S. phylicifolia*, whose pedicel is always longer than the short nectary. The stipules are described as absent or very rare; but small stipules may often be seen on the young shoots. The coma of the seeds is sometimes described as having a reddish tinge; but in all our specimens it is white.

Some other points in which *S. Arbuscula* varies may be briefly noticed. The leaves, which exhibit a considerable range in shape and size, vary also in the pubescence and colour. The underside is sometimes glaucous, sometimes green or with white dots; sometimes distinctly pubescent when young, and at others glabrous. The young branches and buds are often silky, though frequently

described as glabrous. The scales vary in colour, pubescence, length, and shape (roundish, obovate, and oval) ; the style from nearly none to almost one third the length of the ovary, and, with the stigmas, in being thick or thin ; and the capsule in the amount of pubescence and colour. With all these variations there is, however, usually no difficulty in easily recognizing the species.

×Salix Dicksoniana, *Sm.* (*S. phylicifolia* × *S. Arbuscula.*)

Although Wimmer was inclined to think that *S. humilis*, Willd., might be a hybrid between *S. phylicifolia* and *S. Arbuscula*, he does not, in the 'Salices Europææ,' go the length of describing it as such, and Andersson says that it is a modification only of *S. phylicifolia*.

Hybrids between *phylicifolia* and *Arbuscula* might be expected to occur; but if they do they must be very rare. As mentioned under *S. phylicifolia*, it seems quite within the bounds of possibility that *S. Dicksoniana*, Sm., is such a hybrid. Though originally found in "Scotland" by Dickson, and in Breadalbane by Winch, only cultivated specimens appear to be now known, and the characters of these, as well as those given in Smith's description, are in many ways intermediate between *phylicifolia* and *Arbuscula*. As already stated (p. 399), there is some doubt whether Smith's plant and Forbes's are the same ; but the probability seems to be that they are only different conditions of one species, and I have therefore retained Smith's name of *S. Dicksoniana*.

As regards the specimens I have seen, the leaves might belong to either *S. phylicifolia* or to *S. Arbuscula*, though, perhaps, on the whole nearer the latter species. From *S. Arbuscula*, also, has been derived the small stature of the plant ("a foot high," *Smith* ; "18 inches to 2 feet," *Forbes*), the small catkins (♀) appearing with the leaves and with leafy peduncles, the small capsules, which in colour and aspect recall those of *Arbuscula*, and the shortish styles ; but from *phylicifolia* the thicker catkins, more longly-pedicelled capsules with stronger pubescence, and stouter styles and stigmas. The scales are somewhat intermediate in colour and structure.

Both Smith (who places it, in *Engl. Fl.*, next *S. carinata*)

and Forbes (next *Salix prunifolia*) seem to have had some thoughts of the relationship of *Dicksoniana* to *Arbuscula* forms.

Neither Smith's plate (in which the catkins are much too young) nor Forbes's (in which the figured leaves resemble those of *nigricans*) can be called very good.

It is to be hoped that the wild state of *Salix Dicksoniana* will be rediscovered.

Group 7. VIMINALES.

11. SALIX VIMINALIS, *L.*

Though, like other species, liable to modification, *S. viminalis* is, in Western Europe at least, one of the less variable willows, and has no varieties worthy of distinct names, though one or two have been described.

Amongst these are var. *intricata*, Leefe (distinguished chiefly by the cloven, reflexed, and entangled stigmas), and var. *stipularis*, Leefe (with broader leaves and longer stipules).

The ♀ catkins vary a good deal in size. Most of the British and many of the foreign specimens I have seen have much shorter, but proportionately broader, catkins than in Wimmer's published examples, but apparently do not belong to Döll's var. *abbreviata*, in which the catkins are described as linear-oblong.

× SALIX SMITHIANA, *Willd.* (*S. viminalis* × the *Capreæ*.)

The hybrids which *S. viminalis* makes with the *Capreæ* form a group the treatment of which is very difficult—a difficulty not diminished by the manner in which the group has been dealt with by botanists.

For not only have different names been given to one and the same plant, but different plants have had the same name ascribed to them. Thus four, more or less distinct, forms have been called "*S. acuminata*," and the true *S. acuminata* has been described under two other names. Much of this confusion has doubtless arisen, not only from the great variability of the hybrids, but from the fact that the plants described by British authors were not familiar to the Continental salicologists, nor those of the latter to British botanists.

As the group is so specially a British one, it will be of interest to notice its constituents according to the views of some of the later British botanists. It includes, according to:—

1. W. J. Hooker and Borrer: *S. stipularis*, Sm., *S. Smithiana*, Willd., *S. ferruginea*, "And., MS.," *S. acuminata*, Sm., *S. holosericea*, "Willd." (= *S. acuminata*, var. *rugosa*, Sm.).

2. Walker-Arnott: *S. stipularis*, Sm., *S. Smithiana*, Willd., *S. acuminata*, Sm., *S. ferruginea*, And., *S. holosericea*, "Willd.?"

3. Leefe (Journ. Bot. 1871): *S. stipularis*, Sm., *S. Smithiana*, Willd., *S. acuminata*, Sm.

4. Boswell-Syme: *S. stipularis*, Sm., *S. Smithiana*, Willd. (with var. *stipularis*), *S. ferruginea*, And. (with var. *rugosa*), *S. acuminata*, Sm.

5. Babington (1881): *S. stipularis*, Sm., *S. Smithiana*, Willd. (with varr. *rugosa* and *ferruginea*), *S. acuminata*, Sm.

6. J. D. Hooker (1884): As supposed hybrids of *S. viminalis*—*S. stipularis*, Sm., *S. Smithiana*, Willd., *S. acuminata*, Sm., *S. ferruginea*, G. And., *S. holosericea*, Willd., *S. rugosa*, Leefe (= *holosericea*, Hook. & Arn.).

7. London Catalogue (1886): *S. stipularis*, Sm., *S. Smithiana*, Willd. (with var. *pseudo-stipularis*, Lond. Cat.), *S. ferruginea*, G. And., *S. rugosa*, Leefe, *S. acuminata*, Sm.

Wimmer has as the constituents:—

S. Caprea-viminalis, Wimm. (= *S. Smithiana*, Willd.).
S. cinerea-viminalis, Wimm.
S. aurita-viminalis, Wimm.
S. stipularis, Sm.
S. Calodendron, Wimm. (= *S. acuminata*, Sm.).
S. holosericea, Willd.

Andersson praises Wimmer's arrangement, but remarks that authors have described individual specimens rather than the main forms themselves. His own arrangement is as follows. I have added within brackets the equivalents in Wimmer's 'Salices' and in the 'London Catalogue':—

S. stipularis, Sm. (also of Wimmer and Lond. Cat.).
S. Smithiana, Willd.

a. sericans (Tausch).	(*S. Caprea-viminalis*, Wimm. *S. cinerea-viminalis*, Wimm., *p. p.* *S. aurita-viminalis*, Wimm., *p. p.* *S. Smithiana*, Willd., Lond. Cat.)
β. velutina (Schrad.).	(*S. cinerea-viminalis*, Wimm., *p. p.* *S. holosericea*, Willd., Wimm. *S. rugosa*, Leefe, at least *p. p.*)

Var. *ferruginea* (Forbes). (*S. cinerea-viminalis*, Wimm.
S. ferruginea, G. And., Lond. Cat.)
γ. *acuminata* (Sm.). (*S. Calodendron*, Wimm.
S. dasyclados, Wimm.
S. acuminata, Sm., Lond. Cat.)

The weak point of this arrangement is that under one specific name (*Salix Smithiana*) several hybrid plants—having one only of the parents in common—are included. If *S. Caprea*, *S. cinerea*, and *S. aurita* are retained as distinct species—and Andersson did not unite them,—their several combinations with *S. viminalis* should necessarily, according to the method adopted by Andersson in the case of other hybrids, have separate recognition. On the other hand, comes the almost unsurmountable difficulty of distinguishing between them, especially when, as in several cases, the exact parentage has not been proved, and when it is by no means improbable that a second hybridization, either with one or other of the parents or with a third species, has taken place. For this reason I am inclined to adopt provisionally the following modification of Andersson's arrangement:—

S. Smithiana, Willd.
α. *stipularis* (Sm.).
β. *sericans* (Tausch).
γ. *velutina* (Schrad.).
δ. *ferruginea* (G. And.).
ε. *acuminata* (Sm.).

Before proceeding to notice each of these varieties, I may say that, as the result of the study of a very large series of specimens (many of them authentically named), both British and Continental, I have failed to find such a permanence of characters as will serve to definitely separate one form from another. Certain examples can be, without much hesitation, placed satisfactorily under one or other of the varietal names. There are many, however, that cannot really be referred to one variety more than to another, and which, combining to some extent the characteristics of each, form connecting-links. Of some others little more can be said than that they are modifications of *S. Smithiana*.

α. *stipularis*. (*Salix stipularis*, Sm.)

From the statement given above, it will be seen that most of the authors cited retain *S. stipularis* as a species. Even Andersson, who has united the other forms, gives it separate rank. But

from a study, both of descriptions and specimens, I cannot find any grounds for giving *Salix stipularis* a higher position than that which some of the other forms (as, *e. g.*, *S. acuminata*) have been considered entitled to.

Of all the varieties, *stipularis* is the one which is most closely related to *S. viminalis*. From that species it may be distinguished by the broader leaves with less shining pubescence on the under surface, longer and broader stipules, larger catkins, and less sessile capsules; but whilst these are its normal characteristics, they may be all more or less so modified as to afford gradations into *S. viminalis* on the one side or into *β. sericans* on the other. From the latter, its usually tomentose twigs, larger and darker catkins, more sessile capsules, and longer and more filiform stigmas serve to distinguish it, as do also, in the more typical examples, the shape and size of the leaves and of the stipules. But the latter are subject to modification and are not always present; and the former, which vary even in the same specimen, are not unfrequently so similar to those of some conditions of *sericans* that, were it not for the other characters, some examples would certainly be, and frequently are, called *sericans*. In a word, there is no sharp boundary between *S. viminalis* and *stipularis* nor between *stipularis* and *sericans*.

Willows more or less resembling *stipularis* have been named *S. viminalis* var. *stipularis*, Leefe, and *S. Smithiana* var. *pseudo-stipularis*, Lond. Cat. Of these the first includes mere modifications of *S. viminalis*, as well as forms of *stipularis* approaching *viminalis*; whilst "*pseudo-stipularis*" seems to be applied to plants connecting *stipularis* with *sericans*.

The ♂ of *stipularis* seems now to be unknown*, though it is figured both by Smith and by Forbes. The parentage, other than from *S. viminalis*, is doubtful, and some authors have thought that *S. cinerea* is the unknown factor in its origin. Wimmer suggests that it is a hybrid between *S. viminalis* and *S. dasyclados*, Wimm. (=*S. acuminata*, Sm.). I suspect that Wimmer is so far right in supposing that it has originated from a cross between *S. viminalis* and one of the *viminalis-Capreæ* hybrids; but whether this hybrid is *acuminata* is doubtful.

S. stipularis is almost confined to Britain, but, though its value as an osier is said to be small, whether it is really more than an escape from cultivation is very uncertain.

* Since this was written I have found a single ♂ bush—apparently self-sown—near Perth. I fear, however, that it has been lately eradicated.

β. *sericans.* (*Salix sericans*, Tausch.)

This, which includes "*Salix Smithiana*," as generally understood, is a most variable plant, and is almost inseparably connected with *stipularis* on the one side and *velutina* on the other.

From the former, its smaller and paler-coloured catkins, longer-stalked capsules, and usually shorter and thicker stigmas, and from the latter its rather larger catkins and shorter-stalked capsules, are the best points of distinction; whilst another, which separates it from both, is to be found in the usually glabrous twigs. But in any large series of specimens all these points will be found to be subject to much variation.

The leaves are very variable, not only in shape and size, but in the nature and amount of the pubescence. In shape the leaves pass—even in the same example—from ovate-oblong to linear-lanceolate; whilst the pubescence of the underside may either be silky or woolly, shining or dull, copious or almost altogether absent. As a rule, the margin is entire or very slightly crenate; but in forms which approach *velutina* it is more evidently crenate or even subserrate. These latter forms Andersson places in modification 3. *subobscura* (of *sericans*).

Some of the forms, as 1. *latifolia*, And., and 2. *angustifolia* (Wimm.), And., are, as Wichura has proved by experiment, hybrids of *S. viminalis* with *S. Caprea*; but the origin of others (as, *e. g.*, 3. *subobscura*, And.) is not so clear.

Under *subobscura* Andersson cites, as belonging in part, Wimmer's *S. cinerea-viminalis* and *S. aurita-viminalis*; and from the characteristics of this form it seems very probable that *S. cinerea* and *S. aurita* are concerned in the production of some of its modifications. Some of the specimens which have been referred to *S. rugosa*, Leefe, should probably find a position here.

To these forms Andersson adds a fourth—*serotina*, which, however, he thinks is only accidental. It is distinguished by the catkins being shortly but distinctly stalked, and the peduncle furnished with small leaves. Many of our ♀ plants have catkins of this nature.

Var. *sericans* seems to be the most common of the varieties of *S. Smithiana*, but appears to occur more frequently as a cultivated plant or as an escape from cultivation than as a truly wild one. The most abundant form of it is 2. *angustifolia*, or near it. It presents, however, great variability in small particulars.

γ. *velutina.*

(*Salix velutina*, Schrad., *S. holosericea*, Willd., *S. cinerea-viminalis*, Wimm. *p.p.*, *S. Micheliana*, Forbes, Sal. Wob.)

Var. *velutina*, which is often closely connected with *sericans*, and especially with the form *subobscura* (from some states of which it can scarcely be separated), is distinguished by its usually tomentose twigs, serrulate leaves, shorter style and stigmas, and more longly pedicelled capsule. Whilst in *stipularis* the capsule is scarcely stalked, and in *sericans* the stalk is about as long as the nectary, or at most twice as long, in *velutina* it is twice or three times the length. Just as in the other varieties, however, all the characters are liable to modification; so that it becomes impossible to say where certain specimens should be placed.

Though the leaves are normally more or less serrate, they are not invariably so. Forms of this group which have serrate leaves seem to have derived their origin from the hybridization of *S. cinerea* or *S. aurita*, rather than *S. Caprea*, with *S. viminalis*. This appears to be in a measure indicated by the position of the marginal glands. In *S. viminalis* the position of these is somewhat remote from the entire margin. In *S. Caprea* they are also rather remote from the margin, which, however, is by no means always entire. In *S. cinerea* and *S. aurita* the glands are much nearer, if not on the margin, and are often at the apex of teeth. The position, therefore, of the glands and nature of the margin seems to afford a frequent (though not a constant) guide to the possible origin and position of some of the varieties of *S. Smithiana*, such as *velutina* and *ferruginea*.

Var. *velutina*, which, in a greater degree than all the other varieties, appears to have arisen from the crossing of *S. viminalis* with *S. cinerea*, is said to be everywhere rare. Specimens which seem to be referable to it I have seen from Kelvington, N. Yorkshire (J. G. Baker), named *S. cinerea-viminalis*, Wimm., and well marked. Less well-marked are examples from Llangarren, Herefordshire (A. Ley); and Pendeford Mill, Staffordshire, named *S. rugosa* (Dr. Fraser). Dr. Fraser has also found plants near Wolverhampton, which both Leefe and Boswell-Syme have referred to *S. holosericea*, Willd., Koch (=*S. velutina*, Schrad. sec. And.). These, which are ♂, are certainly rightly placed under or near *velutina*, but they are not very like Wimmer's examples of *S. holosericea*, Willd.; and the flowering-twigs and buds are more glabrous than Koch's comparison of them with those of *S. cinerea*

would imply. Koch says that the catkins, buds, and twigs of *holosericea* bear so great a resemblance to those of *cinerea*, that it is impossible to separate the two plants except by the leaves.

Some of the plants named *Salix rugosa*, Leefe, seem to properly belong to *velutina*. Leefe's own specimens (*Sal. Brit. Exs.* No. 30, and *Sal. Exs.* i. No. 22)—of which he writes, "I find it difficult to say whether this plant is nearer to *S. holosericea*, W., or *S. Smithiana*, W.; with much hesitation I have thought it on the whole to belong to the latter"—are very like Wimmer's example (*Coll. Sal.* No. 100) of *holosericea*, Willd., except that Wimmer's is more pubescent. (Andersson remarked of the *Sal. Brit. Exs.* No. 30 specimens that they seemed to him to be *S. acuminata*, Sm.; but Leefe justly says that they do not at all resemble *S. acuminata*, Sm. *Eng. Bot.*, and Ward declares them to be true "*holosericea*, Hook.") Between Dr. Fraser's *holosericea* and the plants from Pendeford Mill, named by him *rugosa*, I see no essential difference in the leaves. The latter are ♀ plants, and from the tomentose twigs &c. seem to be *velutina*. So also is a "*rugosa*" from Clevedon (J. W. White); but other plants, from various sources, named *rugosa* pass by degrees into *sericans* f. *subobscura*.

δ. *ferruginea* (*Salix ferruginea*, G. And.).

This, which Andersson makes a variety of his γ. *velutina*, resembles an intermixture of *S. aurita* and *S. viminalis*, though whether it is really a hybrid of these species requires proof. Wimmer quotes English specimens (from Pinley, T. Kirk), named *S. ferruginea*, under his *S. cinerea-viminalis*; and the examples I have seen from the same locality and collector seem probably referable to *velutina*, which, as has been already mentioned, includes in part *S. cinerea-viminalis*, Wimm.

Var. *ferruginea* is normally a smaller plant in every respect than any of the foregoing varieties, and has more slender and more glabrous twigs, smaller leaves, usually broader above the middle and almost destitute of pubescence, and smaller catkins. Andersson points out that *ferruginea* may be the same as *S. obscura*, Döll, a plant very difficult to distinguish from the smaller states of the modification *subobscura* of *sericans*, from which statement it may be gathered that that form is one of the links between *ferruginea* and *sericans*. Boswell-Syme makes *S. rugosa*, Leefe, a variety of *ferruginea*, distinguished by the different style and

stigmas and more pubescent leaves—all very variable characters in this group. *Salix rugosa*, as said already, I prefer to place under *velutina*, though often passing into *sericans*. Some states of plants which I believe to be *ferruginea* very much resemble Wimmer's examples of *S. holosericea*, Willd.; and just as *sericans* passes into *velutina*, so does the latter, I think, into *ferruginea*.

Herbarium specimens named *ferruginea* are rather a mixed lot, including not only *S. cinerea* and *velutina*, but even perhaps *sericans*. Leefe's *ferruginea* (*Sal. Exs.* iv. No. 89), received from Woburn, seems to be the same as N. J. Andersson's *ferruginea*; and Leefe says that it is G. Anderson's plant, but not that of *Eng. Bot.* On the other hand, another *ferruginea* published by Leefe (*Sal. Brit. Exs.* No. 35, and *Sal. Exs.* iii. No. 63), brought from Essex, is rather a different plant. Leefe says that it is the same as *Eng. Bot.* Sup. t. 2665, but I cannot say that I see the resemblance. Andersson said of it that it was nearest to *S. holosericea*, Willd., and it seems to be very close to if not identical with *velutina*.

Many of the plants called *ferruginea* by English botanists have the leaves densely hairy below, and, apart from the other differences which they display, cannot well be the same as the plant defined by Borrer as minutely hairy.

In a living and wild condition, *ferruginea* is known to me in one locality (in Perthshire) only. Here it has all the appearance of being a natural hybrid between *S. viminalis* and *S. cinerea*, since *S. aurita* does not occur in the immediate neighbourhood. I suspect that here, therefore, it is really a hybrid between *viminalis* and *cinerea*, with a greater proportion of the latter than of the former in it; and that, since the common British form of *S. cinerea* is unlike the common Continental form, *ferruginea* has not been so readily recognized as a state of *S. cinerea* × *S. viminalis*.

ε. *acuminata* (*Salix acuminata*, Sm.).

Wimmer, thinking that the name *acuminata*, having been variously applied, is ambiguous, replaced it by his own name *Calodendron*, which, on account of the doubtful origin of the plant, he prefers to his earlier *Caprea-dasyclados*. Andersson quotes *S. Calodendron*, Wimm., as a synonym of *S. acuminata*, Sm., and says that the latter is closely allied to, if not identical with, *S. dasyclado*, Wimm. (=*S. longifolia*, Host sec. Wimm.).

Comparing Leefe's specimens (*Sal. Brit. Exs.* No. 37, and *Sal. Exs.* ii. No. 27) of *Salix acuminata* with Wimmer's *dasyclados* (*Coll.* No. 99) I find that they are practically identical. Wimmer's exponent (*Coll.* No. 100) of *acuminata* is also like Leefe's specimens, but with a somewhat greater look of *Caprea*. Of Leefe's No. 37, Andersson remarked that it was most certainly *dasyclados*, and very markedly distinct from *acuminata*, Sm.; but Leefe maintained that it was the *acuminata*, Sm., Eng. Bot., and cites Borrer as confirming the name. From a capsule preserved with Smith's original drawings, I have no doubt that Leefe is right as regards his plant, and I have also no doubt that *dasyclados* is a synonym of *acuminata*.

From the specimens which I have seen I am rather inclined to think that *acuminata* deserves a more distinct position than the other varieties of *Smithiana*; but as Andersson has placed it among them, I do not venture to remove it. Its large catkins, densely hairy with crisped hairs, and the long erect woolly pubescence of the capsules, make it easily recognizable. The stout twigs are also most generally densely tomentose, and the large leaves are usually broader upwards and glaucous below.

Andersson defines three modifications—*glabrescens* (to which most of the British specimens belong), *virescens*, and *cinerascens* (also British).

The parentage of *acuminata* is doubtful. Andersson, by saying that its characters are intermediate between *S. viminalis* and *S. Caprea*, seems to think that it has sprung from these species. But Wichura has proved by experiment that *sericans* is produced by the union of *viminalis* and *Caprea*; and it is difficult to believe that in *acuminata* we have not a different combination, arising perhaps from a second hybridization with *S. Caprea*.

From the dubiety which involves the parentage of most of the varieties of *Smithiana*, a series of experiments in hybridizing *S. viminalis* with *S. Caprea*, *S. cinerea*, and *S. aurita*—both separately and in combination with the resulting hybrids—is much to be desired. Till this is done it seems hopeless to expect that the various forms can be extricated from the confusion in which they are at present.

Group 8. Niveæ.

12. Salix lanata, *L.*

This handsome species seems to be a little more variable than

the British descriptions of the plant generally indicate. The leaves vary a good deal in size; in shape from suborbicular to oblong-obovate; and in the amount of pubescence from being persistently woolly to nearly quite glabrous almost from the beginning. The catkins vary in size and in the colour of the pubescence of the scales, which, though usually yellow, sometimes fading to grey, is occasionally grey from the first.

Andersson describes several modifications, but there are none which deserve varietal rank.

Salix lanata seems almost confined (in Britain) to Forfarshire and Aberdeenshire, or at any rate is most common in these counties. Whilst recorded long ago from Perthshire, it seems to have been lost sight of there till recent years, when it was rediscovered by Messrs. Brebner and Haggart and myself in a few places in the Glen Lochay hills.

Var. *Sadleri* (Boswell-Syme).

The plant described by Boswell-Syme as *Salix Sadleri* has now been in cultivation for several years, and has developed some features not seen in the original wild specimens. The stems have increased in thickness and become tolerably stout; the leaves have become larger (some being $1\frac{1}{2} \times 1\frac{3}{4}$ inch). Many of them are more decidedly cordate at the base, and many are also furnished with large ovate-acute glandular-toothed stipules. Though the margins of the leaves were described as entire, yet even in the original specimens the edges of some of the leaves are, more especially towards the base, very finely glandular-serrate or crenate, the teeth, however, being almost reduced to glands. In mature leaves the margin is recurved or thickened. The catkins, which, so far as I have seen, have not increased much in size, may be described as either terminal or as terminal and lateral, according to the view taken of the structure of their peduncles. They are situated at the end of shoots which have two or three leaves. These shoots might be considered to be leafy peduncles, but as their leaves are furnished with stipules and have buds in their axils they are really perhaps a permanent part of the plant, and in this case the peduncle of the catkin must be described as leafless. The scales are oblong and concave, with the tip rounded, emarginate or truncate; in colour they are greenish, with the apex occasionally tinged with red or very shortly black-tipped, and are clothed with long white hairs. The greenish-yellow

style is about as long as the naked young ovary; the yellow stigmas are bifid and spreading, and half as long as the style; the nectary and the pubescent pedicel of the ovary resemble those parts in *Salix lanata.*

S. Sadleri has been supposed to be a hybrid of *S. lanata* and *S. reticulata*; but after long and repeated study of both wild and cultivated specimens, I cannot recognize in it any trace of *S. reticulata*, nor of any species but *S. lanata*, a remarkable form of which I think it must be considered to be.

Serrate leaves are not common in *S. lanata*, though Andersson mentions their occurrence, and I have seen examples. Moreover, in *S. Sadleri* the serration is obscure and not constant. The chief differences lie in the small catkins and in some parts of their structure, but even in these the *lanata* element is preeminent. The whole facies of the plant is that of a small form of *S. lanata*.

× Salix superata, n. hybr. (*S. lanata* × *S. reticulata.*)

A willow which grows, in company with *S. lanata* and other mountain-species, on the rocks at the head of Allt Innis Choarach, Glen Lochay, Perthshire, has required a considerable amount of study to decipher. At first sight the facies of it does not distinctly suggest any particular affinities; but on examination, and keeping in mind the species with which it is associated, a clear relationship to *S. lanata* is revealed. The other parentage seemed very difficult to guess, but a certain undescribable appearance of the plant hinted that it might be found in *S. reticulata.* The possibility of this suspicion being correct further study has made a probability.

The following description is taken from dried specimens:— A very low bush, with erect or ascending branches; stems rather stout, twigs moderate. Bark rich brown, rather shining; young shoots greenish, sparingly hairy, but soon glabrous. Buds shortly oval-oblong, obtuse, at first greenish and very slightly hairy, then pale brown and glabrous. Leaves more or less obovate, base attenuate and often unequal, apex shortly pointed and plicate-twisted; leaves at the top of the shoots the largest (average size about $1\frac{1}{4} \times \frac{5}{8}$ of an inch), those below smaller and proportionately narrower; upper surface yellowish green, scarcely shining, flat, with slightly impressed veins; lower subglaucous dull, with the chief veins conspicuously raised and reticulate; upper surface slightly woolly with short hairs, under with long and short hairs,

both soon nearly glabrous; margin slightly cartilaginously thickened, entire or with a few minute glandular teeth, especially towards the base; petiole medium in length, channelled above, more or less tinged with purple, which colour sometimes also spreads to the midrib, veins, and margin, though these are more frequently yellowish; stipules, when present, rather small, ovate, glandular-toothed. Catkins (♂) terminal on the branches, sessile, short but stout ($\frac{1}{2} \times \frac{1}{4}$ inch); scales roundish, spathulate, rather broad, thin, brown with darker veins, densely pubescent on both surfaces with long straight white hairs; filaments glabrous; nectary half surrounding the base of the filaments, short, split into 2 or 3 obcuneate pieces.

From *Salix lanata* the more erect growth, shape of the leaves, and sessile woolly catkins seem to have been derived; whilst to *S. reticulata* the smaller size and glabrosity of the leaves, the brighter green of the upper surface, the colour of the petioles, veins, and margins, the rounded scales of the catkins, and above all the structure of the nectary, appear to be due. The elevated reticulation of the underside of the leaves is not greater than that which may often be seen in *S. lanata*, but the faint glandular toothing is very similar to what is shown by some specimens of *S. reticulata*.

I have seen other plants which may also prove to be hybrids of *S. lanata* and *S. reticulata*, but judgment on them must be reserved till a larger series of specimens has been obtained.

×Salix Stephania, n. hybr. (*S. lanata* × *S. herbacea*.)

Near Coire Dhubh Ghalair, Glen Lochay, Perthshire, Mr. D. A. Haggart found, two or three years ago, a very small willow whose affinities at first sight were rather difficult to determine, but which after much consideration I concluded to be with *S. lanata* and *S. herbacea*, in whose company it grows. More recently I have found in the same locality another form of the plant, and its characteristics seem to point pretty clearly to a parentage from these species.

It may be expedient to describe both forms. Though I have seen the original plant growing, the following description of it is taken mostly from dried specimens.

Stems more or less buried; branches short, moderately slender, and rather tortuous; young shoots downy, but soon becoming

glabrous. Leaves nearly orbicular, slightly cordate at the base, slightly longer than broad (the largest about $\frac{3}{4}$ inch long); margins more or less crenate-serrate; surfaces bright pale green, but not shining, slightly hairy with white woolly pubescence, more especially on the margin; veins pellucid, anastomosing, above impressed (when young) or slightly raised (when old), below elevated; stipules minute, gland-like. Catkins (large for the size of the plant, being $\frac{3}{4}$ inch in length) rather lax-flowered, on lateral peduncles which are furnished with one or two leaves; scales small, roundish, fuscous-brown but paler at the base, clothed with long white hairs; ovary lanceolate-conic, rather obtuse, glabrous except at the extreme base and on the very short pedicel (thus resembling some forms of *S. herbacea*); pedicel equal to or shorter than the nectary; style moderately long, slender, purple (which colour occasionally tinges the ovary also); stigmas slender, bipartite.

The more recently found form was described when living. It makes a low plant, with flexuous slender rooting stems buried amongst moss. Bark of the twigs rich but pale brown (becoming dark when dried) or greenish brown, glabrous or slightly downy; young shoots greener and sparsely pubescent with long white hairs; buds rather long, oblong, blunt, at first green and hairy, then brown and glabrous. Leaves wavy and half-folded, from orbicular to oblong in shape (the largest $1\frac{1}{2} \times 1\frac{1}{4}$ inches); base cordate, rounded, or slightly attenuated; tip often shortly pointed and twisted; upper surface rather dark green and somewhat shining, lower paler and subopaque, both with numerous minute white dots, which disappear more or less in the dried plant; youngest leaves more or less clothed with long white hairs, but soon becoming glabrous; veins pellucid, reticulate, impressed above (or slightly raised in the older leaves when dried) and elevated below; margin crenate-serrate, pinkish (as are the veins) in the youngest leaves (this colour disappears in the dried plant); stipules few, ovate, glandular-serrate. Catkins (the largest 1 inch long) terminal on leafy stalks; scales spathulate and involvent, mostly pale and either scarcely or distinctly darker-coloured at the apex, clothed with long white hairs; ovary subulate, glabrous, on a pedicel as long as or slightly shorter than the long thin linear nectary; style pale, long and slender; stigmas long, bifid, spreading.

Whilst in both of these forms the *herbacea* element is very per-

ceptible in all the parts, the derivation from *lanata* is shown chiefly in the catkins, though it has left its impression in the other organs as well.

I have some willows (from the same locality) under observation which may prove to be forms of *Salix Stephania* more nearly related to *S. lanata* than the two described above.

In Just's Botan. Jahresber. for 1885 a hybrid willow found by Strömfelt (in Iceland ?) is referred to *S. herbacea* × *lanata*, n. hybr. f. *a. pubescens*, Lundstr., and *β. glabrata*, Lundstr.

13. Salix Lapponum, *L.*

Out of *S. Lapponum*, as in the case of many other willows, several supposed species were manufactured in the early times of salicology. Most of these have now been abandoned, though in the British lists three are still retained as varieties, viz. :— a. *arenaria* (L. *ex p.*), b. *Stuartiana* (Sm.), and c. *pseudo-glauca*, Syme (= *S. glauca*, Sm.). Regarding these, Boswell-Syme says that in his opinion they are scarcely distinguishable; J. D. Hooker characterizes *a* and *b* as only slight varieties, and doubts *S. glauca*, Sm., being the same species; and Babington thinks that *S. glauca*, Sm., is probably not a native, and that it is hardly the same as *a* and *b*.

These varieties are not admitted by the Continental salicologists, who, however, distinguish some other forms. Andersson admits one only—*helvetica* (Vill.), which Wimmer considers to be a distinct species more allied to *S. glauca*, L., than to *S. Lapponum*. Wimmer gives two varieties—b. *marrubiifolia* (Tausch), a very woolly form; and c. *Daphneola* (Tausch), a narrow-leafed glabrous or almost glabrous plant.

Of the British varieties, a. *arenaria* and b. *Stuartiana* have no claim to be maintained as distinct. *b* differs from *a* only in the greater woolliness of the leaves, and is probably the same as Wimmer's var. b. *marrubiifolia*, which also cannot well be retained. As regards *S. glauca*, Sm., the case is different, as will be explained in treating of the var. or subspecies *helvetica* (Vill.).

But whilst no varietal names can well be given, it is not to be denied that *S. Lapponum* shows a considerable range of variation. The leaves of our Scottish plant vary both in shape and size and in the amount of pubescence. In shape they range from narrowly-lanceolate to roundly-ovate, some of the latter simulating the form

argentea or *arenaria* of *Salix repens*, whence arose Linné's confusion of the name *arenaria*. Whilst the leaves are usually well-clothed with pubescence, specimens occur which approach a glabrous condition, but in the absence of fruit cannot be identified with Wimmer's var. *Daphneola*. The catkins vary a good deal in size, and the capsules both in shape and in the structure of the styles and stigmas. In flowers, which seem to be about the same age, and hence comparable, one set has lanceolate-subulate subacute capsules, distinctly pedicelled, but with the pedicel usually shorter than and very rarely as long as the nectary; whilst another set has ovate-conic smaller sessile capsules with longer styles. In other respects the plants do not present much difference, and intermediate forms connect the two sets.

Though *S. Lapponum* is most usually a truly alpine species, rarely descending (in Central Scotland) below an altitude of 2000 feet or thereabouts above sea-level, it does occasionally occur in the low ground. On the south side of the Ochil Hills, in Perthshire, a few bushes (discovered by my friend Mr. W. Martin) grow at the edge of a field at an elevation of only 700 feet above sea-level. So far as I know, *S. Lapponum* has not been found in any other part of that range of hills, which, moreover, are as regards that neighbourhood almost devoid of alpine plants. In this locality (which I have visited) it grows with *S. pentandra*, and could not, to all appearance, have been brought down by water from any sufficiently high altitude.

As mentioned in the 'Student's Flora' and elsewhere, *S. Lapponum* has also been found near Edinburgh. The recorded locality is Colinton (sometimes erroneously written Collington) Woods; and in Edinburgh University Herbarium is a specimen (with ♀ catkins) collected there by Greville in 1824. More recently I have seen, in the same herbarium, other specimens, collected many years ago, from Craigcrook and Dalkeith Woods, both of which places are near Edinburgh. Whether the species has any claim to be considered native in these three localities, or whether it still occurs there, local botanists must decide.

In England this species has been found on Helvellyn only (*B. King*, 1880).

S. Lapponum hybridizes with several other species, and some of these hybrids have been found in Britain. Others probably occur and should be looked for.

Var. or Subspecies *Salix helvetica*, Vill.

Whilst Andersson considers *S. helvetica*, Vill., to be a variety of *S. Lapponum*, Wimmer treats it as a distinct species, placing it in his ninth tribe, whereas *S. Lapponum* is in the fifth. At the same time he says that it must be left to the Swiss botanists to decide whether it is a variety or hybrid of *S. Lapponum* or a distinct species.

S. helvetica combines to a certain degree the characters of *S. glauca* and *S. Lapponum*. From the latter it differs chiefly by the leaves being always or finally glabrous above, by the catkins being on distinct leafy peduncles, by the styles being bifid or subbifid, and by the paler scales. One or other of all these characters may occasionally be seen to a certain extent in true *S. Lapponum*, but yet *S. helvetica* seems to merit varietal or subspecific rank.

From a comparison of specimens and descriptions, I had already come to the conclusion that Smith's *S. glauca* (which is not the Linnean species) was the same as *S. helvetica*, when I noticed that Walker-Arnott had apparently expressed what is practically the same opinion. As a synonym under his variety β of *S. arenaria* (=*S. Lapponum*) he mentions *S. glauca*, Sm., and in the notes he says: "For our var. β we give no stations because we have no reason to believe it indigenous, ... it is commonly cultivated . . . and is common in Switzerland, where we believe our var. α does not occur." Though he is wrong in the latter opinion, yet *S. helvetica* is evidently the Swiss plant he had in view.

Whilst, therefore, there is no doubt that Smith's *S. glauca* is the same as *S. helvetica*, Vill., it is not quite certain that it is a British plant. Smith gives as localities "in the Highlands of Scotland. *Mr. Dickson.* On the Clova mountains; Mr. G. and Mr. D. Don. *Hooker.*" Walker-Arnott says that "Mr. Don's specimens now before us from the Clova Mountains are the same as *S. arenaria*, E. Bot.;" and Babington states that Smith's specimens came from Mr. Crowe's garden. On the other hand, there is before me a specimen in Edin. Univ. Herbarium labelled by Winch "*Salix glauca*, Ben Lawers." This agrees with the plant cultivated by Mr. Leefe as *S. glauca*, Sm., "received many years ago from the Cambridge Botanic Gardens," and both are, without doubt, referable to *S. helvetica*. If Winch's specimen really came from Ben Lawers (and I see no

reason why it should be doubted), then *Salix helvetica* must be admitted as a British plant. At the same time it is desirable that it should be rediscovered.

As regards the figures of Smith's *glauca*, Wimmer condemns, on the authority of Tausch, *Eng. Bot.* t. 1810, as representing *S. glauca*, L., and though he cites *Sal. Wob.* t. 68 under that species, he remarks that it is not good, which, as it illustrates a form intermediate between *S. glauca*, L., and *S. Lapponum*, it could not well be expected to be. Smith cites Haller *Hist.* t. 14 as well representing his *glauca*, and Wimmer cites the same under *S. helvetica*, which affords further evidence of the identity of Smith's species. Smith himself, however, gives *S. helvetica*, Vill., as a synonym of *S. arenaria*, L. (=*S. Lapponum*).

In Europe, whereas *S. Lapponum* is both arctic and alpine, *S. helvetica* is alpine only (Switzerland, Tyrol, and Dauphiné).

× Salix aurita-Lapponum, *Wimm.*

In Edinburgh University Herbarium is an old specimen of a willow collected, I think, by the late Prof. J. H. Balfour, and labelled "Colinton, Edin.," but without a date. It has one ♀ catkin, and is undoubtedly a hybrid between *S. Lapponum* and *S. aurita*, both of which species occur, or used to occur, at Colinton, although, as mentioned under that species, it is doubtful whether *S. Lapponum* is native there. Even if it were planted, that is no reason either for or against the hybrid being of spontaneous origin. There is also a leaf-specimen, collected near Craigcrook in 1832 by the same botanist, which, from the structure of the leaves, I refer to this hybrid. As stated under *S. Lapponum*, that species has also been found at Craigcrook.

Andersson combines the hybrids of *S. Lapponum* with *S. Caprea*, *S. cinerea*, and *S. aurita*, under the name *S. Læstadiana*, Hartm., and places *S. aurita-Lapponum*, Wimm., as *β. opaca*, 2° *subaurita*.

Like other hybrids, *S. aurita-Lapponum* exhibits various combinations of the characters of its parents, but is best known from its close ally *S. cinerea-limosa*, Læstad., by the rugosity of the leaves, especially the young ones. It occurs in several parts of Europe (Lapland, Sweden, Silesia, Switzerland), and ought to be found in the Scottish Highlands, where the parent species not unfrequently grow in sufficient proximity.

A willow, in Kew Herbarium, collected by Lightfoot, but without locality, date, or name, seems to be *Salix aurita-Lapponum.*

× Salix cinerea-limosa, *Læstad.* (*S. Lapponum* × *S. cinerea.*)

A specimen, in Edinburgh University Herbarium, labelled "*Salix cinerea*, Carlowrie, 1838" by, I think, J. H. Balfour, is evidently a hybrid of *S. Lapponum*, and is very like *S. aurita-Lapponum.* From the densely black-pubescent twigs, the abundant rusty *cinerea*-like hairs on the underside of the leaves, and the absence of the rugosity of *aurita*, it is most probably a hybrid with *S. cinerea* rather than with *S. aurita.* The specimen has numerous ♀ catkins, but only young leaves.

Carlowrie is near Edinburgh, and though there is no record of *S. Lapponum* having been found, it may have been planted there as well as in the other places in the district. The hybrid itself is not at all likely to have been introduced, but rather to have had a spontaneous origin.

S. cinerea-limosa, Læstad. (*S. cinerea-Lapponum*, Wimm.; *S. Læstadiana*, Hartm., *β. opaca*, 1° *subcinerea*, And.), seems to be of rare occurrence, recorded from North Scandinavia only. It is not so likely to occur on our hills as *S. aurita-Lapponum.*

× Salix spuria (*Schleich.*), *Willd.* (*S. Lapponum* × *S. Arbuscula.*)

Since *S. Lapponum* and *S. Arbuscula* are (with the exception of *S. herbacea*) probably the two commonest of our alpine willows, they, as might be expected, cross with each other, though, on the Continent at least, apparently not so frequently as might be supposed. The hybrid, though at first at least not recognized as such, has been known for a considerable time under the name of *S. spuria*, Schleich., Willd.; but Wimmer, according to his custom, altered the name to *S. Lapponum-Arbuscula.* It occurs both in Switzerland and the Tyrol, but, judging by its absence from many herbariums, seems to be rare. In Britain, though it is about seventy years since it was first gathered, it has not, until quite recently, been identified, having usually been passed over as a form of *S. Arbuscula.*

Although I have not been able* to examine European examples of *Salix spuria*, I have before me a series of willows which are beyond doubt hybrids between *S. Lapponum* and *S. Arbuscula*, and which must therefore be called *S. spuria*.

Though, as in the case of other hybrids, some specimens show more affinity with one parent than with the other, the examples I have seen are all tolerably intermediate in character. Judging from the words of Andersson and Wimmer, and from the names given to it by Seringe and Gaudin, the Continental plant seems to have a greater resemblance to *S. Lapponum* than has the British one. Andersson says that it is so similar to that species that it can scarcely be distinguished, except by the shorter and more compact catkins surrounded by a few leaves, but especially by the much harder and more glabrous leaves finely serrated on the margin. Wimmer describes it as approaching *S. Lapponum* in the size and clothing of the leaves, and shape and length of the catkins; but to *S. Arbuscula* in the glandular-serrate leaves, which are somewhat shining above, in the narrower ferruginous scales, and in the structure of the stigmas.

The Scottish plant, on the other hand, is more likely to be taken—as indeed it has been—for *S. Arbuscula* than for *S. Lapponum*. In size it is nearer the former than the latter, but otherwise it shows a combination *of the characters* of both. From *S. Arbuscula* it may be distinguished *generally* by the duller colour of the leaves, which are more or less, but never excessively, pubescent—the pubescence combining the silkiness of *Arbuscula* with the woolliness of *Lapponum*, by the finer and more scanty serration of the leaf-margins, by the longer shape of the capsules, longer styles, and usually narrower scales darker at their tips; and from *S. Lapponum* by the firmer and more shining leaves, which are more nearly glabrous and have more or less serrate margins, by the smaller catkins with short leafy peduncles, and by the short stigmas. The characters, however, are more readily seen than described.

I have seen British specimens from the Breadalbane Mountains. In the former it seems to have been first gathered by Sir J. D. Hooker, since in Mr. Hanbury's "Boswell Herbarium" is

* Since this was written I have received (through the kind services of Mr. A. Bennett) Scandinavian specimens of *Lapponum* × *Arbuscula*, which prove to be identical with some of our Scottish examples.

a specimen (without date and without flowers) labelled *S. Arbuscula.* Of recent years it has been found in several places in Breadalbane, with both ♂ and ♀ catkins, by Messrs. Meldrum, Haggart, and Brebner, and by myself.

Group 9. Nitidulæ.

14. Salix Myrsinites, *L.*

Considering how, on the whole, well-marked this species is, great discrepancies occur in the various descriptions. Andersson says that the ovary is sessile, with the nectary passing its base; Wimmer (with whom Grenier agrees) that it is shortly pedicellate with the nectary reaching its body; W. J. Hooker that it is sessile (in *S. procumbens* nearly sessile); Walker-Arnott (for both "species") that the pedicel is usually as long as or at length longer than the nectary; Boswell-Syme that the pedicel is about as long as the nectary; Babington that the ovary is subsessile; and J. D. Hooker that it is distinctly pedicelled.

Then as regards the shape of the ovary, Andersson describes it as ovate-conic rostrate (in β. *Jacquiniana*, thickly ovate and scarcely pedicellate); Wimmer, conic-oblong, always obtuse in α, more slender and often somewhat acute in β. *Jacquiniana*; Koch, lanceolate-acuminate from an ovate base, at first sessile and hairy, at length very shortly pedicellate and glabrous; Grenier, ovoid shortly conic; W. J. Hooker and Walker-Arnott, lanceolate; Boswell-Syme, lanceolate-conical or conical-subulate; Babington, ovate-subulate.

(By Andersson the ♂ catkins are described as yellowish, the anthers at length becoming blackish; but Wimmer more correctly says that the filaments are purplish, and the anthers purple-violet.)

From the descriptions of the ovary, it would appear that British botanists attribute a longer pedicel to the species than the Continental botanists do, and that on the whole they are inclined to describe the shape of the ovary as lanceolate.

The result of the examination of a number of specimens shows that there is a considerable range of variation in the length of the pedicel and shape of the ovary, without, however, any notably extreme forms. The Central-European plant seems usually to have a shorter capsule and pedicel than the North-European. Scottish examples are more (though not altogether) in accord-

ance with the latter than with the former. In them the pedicel is always (so far as I have seen) present, and is often twice as long as the nectary, though it varies in length even in the same catkin.

In addition to these variations in the ovary, the structure of the style and stigmas, the shape and size of the catkins and of the leaves, as well as the habit of the plant, are all subject to modification, so that as regards the varieties *serrata* and *arbutifolia* of British lists there is no reason for which they deserve to be retained.

Nor is it by any means evident that *Salix procumbens*, Forbes (now considered by most botanists to be a form of *S. Myrsinites*) has any characters to warrant its retention. Walker-Arnott maintained it as a distinct species chiefly on account of its elongate catkins; but, as Boswell-Syme points out, this is not a character of any constancy in *S. Myrsinites*, nor are there any sufficiently distinct characteristics in the habit of the plant, the shape of the leaves, or the structure of the style.

× Salix Wahlenbergii, *And.* (*S. Myrsinites* × *S. nigricans.*)

In the 'Prodromus' Andersson uses the name *S. myrsinitoides*, Fr., for the willow which Wimmer calls *S. Myrsinites-nigricans*; but in Blytt's 'Norges Flora,' pt. ii. 1874, he alters the name to *S. Wahlenbergii*, And., and gives as synonyms *S. punctata*, Wahl., *S. myrsinitoides*, Fr., *S. nigricans *borealis β. punctata*, Hartm., and *S. Myrsinites-nigricans*, Wimm.

Both Andersson (in the 'Prodromus') and Wimmer (in his 'Salices') appear not to have been very well acquainted with the species, as their descriptions do not altogether agree, and neither was sure of the distribution. From the 'Norges Flora,' however, it would seem that Andersson had become more familiar with the plant, since the description is greatly amplified. After remarking that, through the hybridization of the very variable *Myrsinites* with the still more variable *nigricans*, a great number of intermediate forms occur, he proceeds to notice three chief modifications, namely, a. *subnigricans*, b. *coriacea*, and c. *sub-Myrsinites*. Since, however, these forms pass imperceptibly into each other, it seems scarcely worth while retaining these names as those of distinct varieties.

In its best form *S. Wahlenbergii* combines the characteristics of its parents, deriving from *Myrsinites* the rigidity, glossiness,

and in part the venation of the leaves, the often erect leafy-peduncled catkins, and the structure and colour of the style and stigmas; and from *nigricans* the somewhat tomentose twigs and leaves, the greater thinness of the latter, and their greater tendency to become black in drying, the often longer petioles, and the often longer pedicels of the capsules. But, as Andersson remarks, some specimens are very difficult to separate from *nigricans*, and others pass imperceptibly into *Myrsinites*, and thus it is often by no means easy to determine some of the less intermediate examples.

In Britain *Salix Wahlenbergii* is possibly not very much rarer than *S. Myrsinites* itself, since it occurs in many of the localities of the latter, though it has been passed over as *Myrsinites* and sometimes as *nigricans*. I have seen good intermediate specimens from Perthshire, Forfarshire, and Aberdeenshire—first gathered in the latter two counties by J. H. Balfour, Greville, and their contemporaries; and in addition many examples gradually passing into either *Myrsinites* or *nigricans*, and often very difficult to separate.

Neither Wimmer nor Andersson seem to have been acquainted with the ♂ plant, though the former quotes of the catkins "♂ elongati, graciles." The ♂ has, however, been found on Ben Laoigh by the Messrs. Groves, and on Ben Heasgarnich by myself. These ♂ plants have leaves near *Myrsinites*, catkins short, thick, on leafy peduncles, and anthers subglobose and yellow, this yellow colour being the chief point in which they differ from *Myrsinites*.

Salix MacNabiana, MacGillivray ('Edinb. New Philos. Journ.' ix. p. 335, 1830), is possibly this hybrid, but MacGillivray's own herbarium specimens (now in the possession of Dr. Roy, of Aberdeen)—from the Corrie of Loch Kandor, where the hybrid is common—are very close to, if not identical with, *Myrsinites*, though they are too poor for absolute certainty.

A hybrid between *S. Myrsinites* and *S. phylicifolia* probably occurs in Britain, but I have not yet seen examples sufficiently certain to enable me to include it in the list.

× SALIX SAXETANA, n. hybr. (*S. Myrsinites* × *S. aurita.*)

A willow gathered by myself some years ago, and more recently by Messrs. Groves, on Ben Laoigh, Perthshire, puzzled

me for a long time. I have found quite lately, however, several bushes which, by their range of variation, indicate pretty clearly the affinities. The plant seems, with little doubt, to be a hybrid of *Salix Myrsinites* and *S. aurita*, both of which occur on Ben Laoigh, but is so altered that at first sight it does not sugges either of the parents. As yet I have seen ♀ catkins only—from at least three bushes, but I think that the ♂ also occurs*.

The following description is made from a form tolerably intermediate in its characters. It makes a low thick-stemmed bush, with olive-green (turning brown when dried) slightly shining twigs, which are at first somewhat pubescent, but soon become glabrous. Leaves rather large (2×1 inches), especially at the top of the shoots, obovate, with a more or less oblique short point; margin wavy, coarsely crenate-serrate; upper surface dark shining green, with (when living) the veins slightly impressed; under surface dull pale green or subglaucous, with the primary veins raised; young leaves slightly pubescent, soon becoming glabrous, except on (to a greater or less extent) the midrib and rather long petiole. Stipules very small, ½-cordate, glandular. Catkins moderate in size, erect or spreading, on long or short peduncles which are furnished with several small leaves whose axils have buds in them; scales narrow, pointed, with the upper half or third fuscous black; capsule rather small, conical-subulate, clothed with dense white hairs, and on a pedicel which is three to four times as long as the small quadrate yellow nectary; style rather short, bifid to, or nearly to, the base; stigmas rather short, bifid, spreading.

Specimens from another bush show much the same characters,

* Since this was written, the supposed ♂ plant has flowered in cultivation. The following description was taken from a living specimen:—Catkins ovate-oblong, lateral, on a peduncle with about three leaves which are as long as the catkin. Peduncular leaves minutely stipulate, glabrous, pale dull green, with the chief veins yellowish green and impressed above; below clothed with rather straight hairs on the midrib, chief veins, and apical margin, dull paler green, with the principal veins yellowish and raised; veins translucent, those which arise from the midrib becoming subparallel to it; margin finely glandular-serrate. Scales broad, greenish white below, the upper third or fourth becoming black (the scales at the top of the catkin are red between the pale and black portions); upper part sparingly hairy with long whitish hairs; apex usually emarginate or erose. Filaments pale, glabrous. Anthers (with cells unequal) subquadrate, at first tinged with red, becoming yellow. Nectary rather small, thick, oblong, usually entire, but sometimes divided into two or more irregular pieces, green or yellowish-green. The date of flowering was the end of May.

but the capsule is less subulate and more cylindrical and obtuse, and seems to show below the hairs a trace of the scaly pubescence which is sometimes characteristic of *Salix Myrsinites*.

A third bush, while practically the same as the others, shows rather a greater affinity with *S. aurita*. The twigs are more slender; the young leaves more pubescent; the margins of the leaves more serrate; the catkins smaller, with narrower, more ferruginous scales; the capsule more like that of *aurita*, with usually an almost obsolete undivided style, and very short, bifid, and erect stigmas.

It will be seen from the foregoing that, though the leaves have to a great extent retained the outline of those of *S. aurita*, they have lost the rugosity characteristic of that species, though in their young state they show in part the pubescence. From *S. Myrsinites* the shining upper surface has been derived, but the substance is thinner than in that plant. The capsule structure shows varying affinities with both species.

Besides the Ben Laoigh examples, I have seen specimens collected in Clova, Forfarshire, by the Rev. W. R. Linton, which—although there are no catkins—I believe to be another form of *S. saxetana*. In shape the rather small leaves recall both *S. Myrsinites* and *S. aurita*. They are roundish- or oblong-obovate, with short more or less oblique points; green but (at least when dried) only slightly shining on either surface; margins finely crenate-serrate; both surfaces sparingly pubescent—the pubescence becoming scantier, but scarcely altogether vanishing in the older leaves; young leaves rugose, with impressed veins above and raised veins below; older leaves flatter above, but with conspicuous pale (when dried) raised veins below; petioles rather long; stipules present, but small. I think that, so far as the leaves go, there can be no doubt as to the parentage of this plant.

× SALIX SERTA, n. hybr. (*S. Myrsinites* × *S. Arbuscula.*)

A specimen in Mr. F. J. Hanbury's "Boswell Herbarium," labelled "*Salix Arbuscula.* Breadalbane Mts., Lyon," seems almost certainly a hybrid between *Myrsinites* and *Arbuscula*.

The leaves recall both species, and are rather small, slightly obovate, shining above, and dull and glaucous below, finely crenate-serrate on the margins, quite glabrous (except when very young, when they have the pubescence of *Arbuscula*), and veined

in the style of *Myrsinites* rather than *Arbuscula*. The catkins (♀), which are borne on terminal and lateral, rather long, leafy peduncles, are $1\frac{1}{2}$–2 inches long, stout and cylindrical; scales small and rather narrow, very hairy; capsules sessile or nearly so, oblong-conical, obtuse, coloured like those of *Arbuscula*, and hairy; style slender, rather short, with the apex bifid; stigmas short, slender, bifid. The plant is quite intermediate between its supposed parents.

Here also may belong a scrap in the same herbarium labelled "*Salix prunifolia*. Breadalbane Mts. J. D. Hooker." If it does, it is nearer *Arbuscula*. The small leaves are rather intermediate; the capsule more slender than in the above; the style very short, and the stigmas very short and thicker.

Under *S. Arbuscula*, Walker-Arnott describes a var. β from Ben Lawers, with "leaves (broadly or roundish ovate, prominently veined above) green, but scarcely shining on both sides." Of it, he says that it is precisely intermediate between *Arbuscula* and *Myrsinites*, and may perhaps be a hybrid. It was found only once.

15. Salix herbacea, *L.*

S. herbacea varies in many small particulars, such as size, shape and extent of serration of the leaves, downiness of the young shoots, &c. The pedicel of the capsule varies a little in length, and in being glabrous or silky, the silkiness sometimes extending to the base of the capsule. The style also varies in length. Occasionally the capsule has a few hairs on it, and more rarely well-developed lines of hairs. The most extreme state of this form which I have seen is in a plant, collected by Dr. Greville in Corrie Kandor in 1830, which has, moreover, the style bifid to the base. A less extreme form I have found near Glen Tilt. Andersson describes a var. *subpolaris* whose capsule has lines of hairs, but it differs from the type in also having entire leaves.

×Salix Grahami (*Borr.*), *Baker*. (*S. herbacea* × *S. phylicifolia*?)

Under *S. Myrsinites* Sir J. D. Hooker has the following note:—"*S. Grahami*, Borr. MS., is only known from ♀ specimens, cultivated in the Edin. Bot. Garden, said to have been brought by Prof. Graham from Frouvyn in Sutherlandshire.

It appears to me to be a form of *Salix Myrsinites*, with smaller catkins, paler scales, and a perfectly glabrous capsule with a rather long very silky pedicel; and not allied to *S. polaris* or *herbacea*. Syme suggests it to be a hybrid between *herbacea* and *nigricans* or *phylicifolia*; and Nyman a subsp. of *S. retusa*, L. The Engl. Bot. figures of the ovary and scale are very incorrect. A similar plant occurs in Muckish Mt., Donegal."

Having examined living specimens of both the Scottish and Irish plants, I think that Boswell-Syme is probably correct in his suggestion of the parentage; but I cannot agree with Leefe in considering that the Irish plant "is as nearly as may be identical" with the Sutherland form. In fact, I suspect (although, till it is proved by experiment, it is only a conjecture) that whilst *S. herbacea* is one of the parents of both, *S. phylicifolia* is the other parent of the Scottish plant, and *S. nigricans* of the Irish. If this be the case, the former must bear the name of *S. Grahami*, and the latter that of *S. Moorei*.

The published descriptions of neither of them are absolutely correct, but it will be sufficient to indicate the points in which the two differ.

× *S. Grahami* (Borr.), Baker.

Young leaves brighter and more shining, rather broader, less pubescent, the pubescence being more of the nature of that of *S. phylicifolia*, but not markedly so. Scales involvent, broader upwards, obtuse, subemarginate at apex, hairy at the base and ciliate on the margin. Pedicel of the ovary silky-hairy, the pubescence spreading more or less over the base of the ovary, which is otherwise glabrous. Style rather stouter; nectary oval-oblong.

× *S. Moorei* ("Watson, L. C.").

Young leaves duller, narrower, and more hairy, the pubescence resembling that of *S. nigricans*. Scales much longer in proportion, narrow oblong, subobtuse at apex, and more hairy. Pedicel of ovary apparently longer, glabrous or slightly hairy; ovary more or less pubescent towards the apex. Nectary linear-oblong, about as long as the pedicel, finally much shorter.

The most apparent differences between the two lie in the very differently shaped scales and in the pubescence of the ovary.

Boswell-Syme describes the peduncle of the catkin of the Suther-

land plant as glabrous, but, in all the specimens I have seen, it, as well as the rhachis, is distinctly pubescent. Stipules were unknown him and are certainly rare, but when present are small, more or less narrowly ovate, and toothed. Possibly they are more frequent in *Salix Moorei* than in *S. Grahami*.

In some wild specimens of *S. Moorei* (kindly lent me by Mr. F. Moore) there are ripe capsules. These are subulate from an ovate base, and about $\frac{1}{8}$ inch long. The facies of the wild specimens favours the theory that *nigricans* is one of the parents.

The late Dr. Moore, in recording the occurrence of the Irish plant, says that it is the same as specimens of *S. Grahami* from the Sow of Athole in Perthshire. I have not been able to learn anything about this Sow of Athole plant; but in Borrer's Herbarium at Kew is a plant, placed under *S. Arbuscula*, which was collected on that hill by Mr. J. Ball. Its condition is bad, but it seems not to be *S. Arbuscula*, and *may* be a form of the Sutherland *Grahami*, though not agreeing with it in the scales or leaves.

× Salix simulatrix, n. hybr. (*S. herbacea* × *S. Arbuscula*.)

Under this name I place specimens of four plants from the Breadalbane Mountains, which, though unlike each other, seem to be probably hybrids of *S. herbacea* with *S. Arbuscula*. They all, however, require further investigation. These plants and their characters are as follows:—

1. From Coire Dhubh Ghalair (J. Brebner). Nearer *S. Arbuscula* than *S. herbacea*. From the latter it derives its habit, slender arcuate branches, roundish oval thinner leaves, and pseudo-terminal catkins (*i. e.* at the end of a branch and subtended by a leaf, but with a bud between the leaf and the peduncle); from *S. Arbuscula* it has the thicker trunk and more oval leaves, dull glaucous green below and with the smaller veins less prominent. Whilst bearing a strong resemblance to *Arbuscula*, it is not exactly like any of the numerous specimens which I have seen. Compared with examples of the latter of the same age, it may be distinguished by the leaves being thinner, more shining above, and roundish oval in shape; by the habit and slender branches; and by the position of the catkins. There is only one catkin on the specimen, and that not in good condition. The capsules, whilst resembling those of *Arbuscula*,

seem to be a little longer in proportion to their size than in that species.

2. A specimen in F. J. Hanbury's "Boswell Herbarium," on a sheet with the label "*Salix prunifolia*, Breadalbane Mts., J. D. Hooker." This has no flowers, but is in habit nearer *herbacea* than No. 1, with which in the leaves it quite agrees.

3. Meall Dhuin Croisg (W. Barclay and R. H. Meldrum). In habit and leaves near *herbacea*, but in its catkins nearer, apparently, *Arbuscula*. I once thought that this might be a form of *S. Moorei* nearer *S. herbacea*, but now I suspect that *S. Arbuscula* is more likely to be one of its parents. The catkins are lateral on leafy peduncles, and are moderately long. The capsules are pubescent, intermediate in shape between those of *Arbuscula* and *herbacea*, and pedicellate, with the pedicel about as long as the long linear nectary. The style is of medium length, and the stigmas rather short, thick, and cleft. The leaves much resemble those of *herbacea*, but are not quite identical. It is beyond doubt a hybrid of *herbacea*, but whether with *Arbuscula* is a little uncertain.

4. A specimen in the Edinburgh University Herbarium, labelled "*Salix vaccinifolia*, Craig Chailleach, Perthshire; Dr. Hooker." This has young catkins and young leaves only. The leaves seem essentially the same as those of Nos. 1 and 2. The catkins are lateral and terminal, on leafy peduncles, very small and subglobose. The scales are glabrous on the back and ciliate on the margins, and very similar to those of *herbacea*. The ovaries are like those of *Arbuscula*, but the style and stigmas like *herbacea*. Larger and older specimens are desirable.

× Salix sobrina, n. hybr. (*S. herbacea* × *S. Lapponum*.)

A morsel of a willow gathered on the east side of Ben Chat, in Athole Forest, Perthshire, by Dr. Roy, of Aberdeen, and by myself, had long been a puzzle to me (especially as it had no catkins) till I came to examine a plant found by the Rev. E. S. Marshall in Glen Fiagh, Clova, Forfarshire, in 1888. These latter specimens, being in better condition and having ♀ catkins, show that it is a hybrid between *S. herbacea* and *S. Lapponum*.

The examples which I have seen are so intermediate between the parent species, that they are not strikingly like either of them. In size the plant is like *herbacea*, but in habit more like *Lapponum*, especially in the comparatively (to the size) stout,

knotty, tortuous, reddish-brown glabrous branches. The leaves are small, oval, at first woolly on each side, but becoming subglabrous, and slightly shining on each surface; margin obscurely serrate; base rounded; tip (sometimes twisted) subacute and subcartilaginous, as in *Lapponum*; veins and margin pellucid; veins finally raised and reticulate on the upper surface; lower surface lineately veined and reticulate with raised veins. Catkins short, few-flowered, lateral on long leafy peduncles; scales large and broad, obovate, subtruncate, brown with darker tips and long white hairs; capsules sessile, white-woolly, at first conical, then subulate-conical; style moderate, about as long as the rather thick entire or bifid suberect stigmas; nectary long linear. Young shoots pubescent.

A willow from Clova (Dr. Greville, 1824), in Edinburgh University Herbarium, may belong here, but if it does it is nearer *herbacea* than the above. It has leaves only.

Since this description was written I have received specimens of *S. Lapponum-herbacea* (no authority for the name, and *S. alpestris*, And., given as a synonym) from Sweden. These are, to all intents, the same as the Scottish plant, though rather more luxuriant. "*Alpestris*" is the name adopted by Andersson (in the 'Norges Flora') for the hybrid between *S. herbacea* and *S. glauca*, and is placed with four other, variously composed, hybrids under *S. norvegica* (Fr.), And.

I have also seen a more numerous series of specimens collected in Clova by the Messrs. Linton, as well as what appears to be another form (collected by the same botanists) from Craig-na-dala Beg, Aberdeenshire. These specimens exhibit various degrees of combination between the supposed parents.

×Salix margarita, n. hybr. (*S. herbacea* × *S. aurita.*)

In Messrs. Groves' herbarium is a very curious willow, found by them on Craig Loigste, on the south side of Ben Challum, in Perthshire, in 1855; and growing in the Edinburgh Botanic Garden are two willows (for specimens of which I am indebted to Mr. Lindsay, the Superintendent) which, though not identical with the Messrs. Groves' plant, are apparently another form of the same species. The Edinburgh Garden plants were found in 1875, by the late Prof. Dickson and the late Mr. J. Sadler, near Tyndrum, and probably both on Ben Challum, since a specimen

sent by Mr. Sadler to Mr. Leefe, and now in Kew Herbarium, has Ben Challum given as the locality.

Mr. Sadler describes the wild plant as having "a dwarf procumbent habit;" and Messrs. Groves' specimens show this, but the cultivated specimens sent to me look as if they had become more upright.

The following is a description taken from living specimens of the plant found by Mr. Sadler, and now in cultivation :—

Twigs divaricate, slender, straight or subflexuose, purple-brown, glabrous, shining; older bark brown or very dark olive-green, roughened but shining; youngest shoots with white pubescence, when older green, or where exposed to the light dark red-brown or purplish, shining, but with a few hairs. Buds at first pubescent, then glabrous, yellowish-red, acute. Stipules (rare) half-cordate, hairy, glandular-serrate on the margin. Leaves thin, dark green, slightly shining above, paler and dull below, at first densely woolly with brownish-white hairs, at length almost or quite glabrous; roundish; base rounded, subcordate, or unequal and slightly cuneate; tip with a twisted point, or truncate, or subemarginate; upper surface concave; margin thickened and incurved serrate-crenate, with incurved glandular teeth; upper surface rugose from the impressed veins, under surface with raised reticulate veins, smaller veins pellucid; petioles rather long and slender; the largest leaves $1\frac{1}{4}$ inch long and broad, but most of them much smaller; vernation involute. Catkins (♀) small (less than $\frac{1}{2}$ inch long), dense-flowered, on lateral leafy peduncles of about the same length as the catkin; peduncle-leaves 2–4, ciliate, with buds in their axils, and stipulate; peduncle and rachis downy; scales oblong, narrow and long, concave, glabrous on the back, ciliate at the apex, and with a few hairs on the inner surface, greenish yellow, those at the top of the catkin tinged with pink at their tips; ovary conical from an ovate base, subobtuse, with coarse woolly white pubescence; pedicel downy, nearly three times as long as the nectary, which is thin in texture, oblong or widened upwards, entire or cleft once or twice at the apex or nearly to the base; style very short, thick, greenish yellow; stigmas bifid, suberect, as long as the style.

In one specimen the uppermost scales are widened upwards, broader and involvent, and have a few hairs on the back.

In Prof. Dickson's plant the characters are much the same. The older bark is duller, the buds are less acute, and the catkin-

scales more uniformly narrow, the catkins rather larger, and the stigmas spreading.

Messrs. Groves' specimens have often obovate and sometimes oblong leaves, the largest about 1 inch long by $\frac{3}{4}$ inch broad, but most of them less than half that size; slender, more flexuous twigs; young leaves less hairy; petioles rather shorter; the solitary catkin more slender, with scales shorter, broadly obovate, and involvent, the pedicel of the ovary rather shorter, and the stigmas larger and spreading.

There can, I think, be no doubt that this species is a hybrid between *Salix herbacea* and *S. aurita*. The Edinburgh Botanic Garden plants are, in the shape of the scales and in the capsules, nearer *aurita* than *herbacea*, to which, in these parts, Messrs. Groves' specimens are more related. Both sets are, however, intermediate in character between their parents.

16. Salix reticulata, *L.*

In several small points *S. reticulata* departs from the usual descriptions of this well-marked species, but these variations require no special notice. The margin of the leaf is described as entire, but on the apparent margin (though not usually on the real edge) there is frequently a row of glands which give the appearance of a minute serration.

Andersson mentions two varieties—*α. typica* and *β. nivalis* (*S. nivalis*, Hooker), the latter being a remarkable small form which occurs in Iceland, Spitzbergen, and N. America. The var. *α. typica* is divided into:—1. *glabra* (leaves quite glabrous on each side), and 2. *sericea* (leaves more or less villous, and the margin towards the base here and there glandularly subserrate). The latter is the more frequent form in limestone districts of S. Europe. Whilst the Scottish plant must be referred to 1. *glabra*, I think that the Glen Callater examples retain the hairs on the underside of the leaf (both surfaces are more or less hairy when young) for a longer period than the Perthshire ones do.

I have seen two Scottish plants which have been referred to *S. reticulata*, but which seem to be evidently hybrids of it with other species. They are well worth further investigation.

One of these plants is in the British Museum Herbarium, and is labelled "*Salicis reticulatæ* varietas ?, Ben Lawers, Perthshire, 1793, R. Brown." Unfortunately it has no flowers, but it may be thus described:—

In habit like *S. reticulata*, but stems more slender, rooting, chestnut-brown. Petioles very short, being little, if at all, longer than the bud in the axil. Leaves narrowly oval or elliptic, some of them rather broader beyond the middle, attenuate at the base, flat above and below and glaucous below; midrib and veins slender, primary veins leaving the midrib at a very acute angle and running parallel to it, secondary veins anastomosing; margin cartilaginously thickened, entire; texture apparently thinner than in *reticulata*; young leaves with a few hairs below, soon becoming quite glabrous. Largest leaves nearly 2 inches long by $\frac{3}{4}$ inch broad; average size $1\frac{1}{2} \times \frac{1}{2}$ inch. The very short petioles &c. indicate the distinctness of this plant (which may be provisionally called *S. sejuncta*) from *S. reticulata*.

The other plant referred to is in the Kew Herbarium, and is labelled "*Salix reticulata*, L., And." (meaning that Andersson certified it), "Scotland, Herb. Lambert."

It is quite a different looking plant from *S. reticulata*. The stems are straighter than in that species, and more or less woolly. The leaves are less strongly reticulate, quadrately oval, cordate at the base, distinctly and rather closely crenulate-serrate, woolly on each side but more especially above; petiole very short, and very woolly, as is the young shoot. The catkins are *lateral*; the scales (not in good condition) seem to be larger; capsule (burst) sessile, glabrous, shaped as in *reticulata*; style rather long; stigmas rather long, entire or bifid. This apparently very distinct plant I provisionally name *S. soluta*; but I am unwilling to place either it or the other in the list till they have been rediscovered.

×Salix semireticulata, n. hybr. (*S. reticulata* × *S. nigricans*?)

A willow which was discovered at an altitude of 2300 feet on Meall Ghaordie, in Perthshire, by Mr. James Brebner, has a superficial resemblance to *S. Grahami*, chiefly from the habit of the plant and the shape of the leaves. It seems, however, to be a hybrid between *S. reticulata* and probably *S. nigricans*, although it has not much resemblance to either of these species. It may be thus described:—

Branches slender, long and trailing; bark fuscous brown, glabrous and shining; shoots of the year dull paler brown, white-pubescent. Buds red-brown, at first slightly pubescent

with white hairs, finally glabrous, quadrately-ovate and obtuse. Leaves at first half-folded, the older ones flatter, oblong-orbicular, truncate or subcordate at the base, obtuse or slightly twisted at the apex; margin slightly reflexed, slightly and rather remotely glandular serrate-crenate or nearly or quite entire, youngest leaves less obscurely crenate; surfaces at first, and especially below, more or less furnished with white woolly adpressed hairs, afterwards glabrous above and nearly or quite glabrous below; upper surface dark green, shining, reticulately rugose from all the veins, even in the smallest, being impressed (when dried, however, some of the veins are raised); under surface dull paler green, white-dotted as is also the upper surface, the veins including the smaller ones somewhat thickened and reticulately prominent, more especially when young; veins numerous, pellucid; primary veins forming an acute angle with the midrib, those towards the base of the leaf more approximate; larger leaves about $1 \times \frac{4}{5}$ inch, smaller $\frac{1}{2} \times \frac{1}{2}$ inch; petiole about $\frac{1}{4}$ of the lamina in length, grey-woolly above; stipules (rare) minute, roundish, glandular, soon disappearing; leaves involute in vernation. Catkins lateral on peduncles about as long as the catkin, and with three or four leaves with buds in the axils, the leaves similar to the other leaves but smaller, and the upper surface mostly glabrous, narrowly red at and near the apex; catkins ovate, short, compact; rachis stout, woolly; scales membranous, brownish, clothed with long straight white hairs on both surfaces, broadly spathulate, obtusely rounded and erose at the apex; capsules (large for the size of the catkin) ovate subulate, slightly compressed obtuse (acute in the young ovary), green tinged more or less with red-brown, slightly hairy especially towards the top, but sometimes becoming almost or quite glabrous; pedicel silky or glabrous, stout, shorter than the long, linear, very thin nectary; style moderate, bifid at apex; stigmas about as long as the style, bifid, erect, but twisted and recurved at the apex *.

* The above description was taken from the rather old catkins of the wild specimens. The following is from a younger catkin from a cultivated plant:—Scales veined, broadly obovate, involvent; apex truncate or slightly rounded, and sometimes slightly emarginate; greenish white at the base, brownish, reddish brown, or red in the middle (the upper scales being the brightest coloured), and black at the apex; upper part of both surfaces clothed with long white hairs. Ovary subulate-conic, shortly pedicellate, both ovary and pedicel hairy with long hairs or somewhat glabrous below; style stout, yellow, its

In some specimens the midrib and primary veins, as well as the petiole and margin, are somewhat reddish in colour.

A willow which Mr. Brebner found on a neighbouring rock to the above much resembles it, but has flatter, more oblong leaves, more closely but shallowly crenate-serrate or almost serrate, more distinctly white-dotted above, less rugose above and less reticulate below, veins less pellucid, and margins less reflexed. I have not yet seen catkins *.

In Smith's herbarium is a willow labelled in ink "*Salix elliptica*, nov. sp., Clova Mountains, Mr. Thos. Drummond, Mr. W. Robertson, 1825," and in pencil "I have this as a rounder-leaved var. of *S. Myrsinites*." It has no catkins, but—from memory—is much like *S. semireticulata*. I think that it has no connection with *S. Myrsinites*.

× Salix sibyllina, n. hybr. (*S. reticulata* × *S. Lapponum*.)

In Edinburgh University Herbarium are four small specimens of a willow found by Greville near Loch Brandy, Clova, in 1824. They are labelled "possibly a pilose state of *S. reticulata*."

Though without flowers, these specimens so evidently belong, I think, to a hybrid between *S. reticulata* and *S. Lapponum*, that I have ventured to give them a name and a place in this list.

The twigs are intermediate (between the parents) in character, rather stout, shining, chestnut becoming grey; young shoots slender, somewhat pubescent. Leaves small (the largest $\frac{3}{4} \times \frac{1}{2}$ inch, but many are much smaller), ovate, ovate-oblong, or subrotund, at first woolly on each surface but more especially below, finally nearly glabrous above and slightly shining; upper surface at first slightly impressed by reticulate veins; under surface with primary veins raised, the others scarcely or slightly raised, reticulate; margin incurved, with obscure glands as in *reticulata*; apex obtuse, or with a short cartilaginous point as in *Lapponum*; base subcordate, rounded, or shortly cuneate; petioles very short.

Whilst bearing no striking resemblance to *reticulata*, it yet

base hidden by the scale; stigmas equal in length to the style, thick, bifid, curved, and connivent, yellow. Nectary much longer than the pedicel of the ovary, linear oblong, rather thick, yellowish green.

* A cultivated plant has since this was written produced ♀ catkins which, though not perfectly identical with those of the other plant, are not essentially different in structure. In the structure of the stigmas and scales there is much resemblance to *S. Grahami*.

shows in the venation, structure of the margin, and shape of the leaves, its relationship to that species. The specimens are too old to show the colour well, but that of the principal veins is in the direction of *S. reticulata*, namely reddish.

From the look of the examples and the dead wood about them, they seem not to have been in robust condition, and probably the plant grows much larger.

C. SYNANDRÆ.

Group 10. Purpureæ.

17. Salix purpurea, *L.*

Whilst both British and Continental salicologists distinguish several modifications or so-called varieties of *S. purpurea*, they are not altogether agreed as to what these are or as to the names they should bear.

In Britain the "species" into which Smith and Borrer divided *S. purpurea* are still retained as varieties of that plant. These are *Lambertiana*, Sm., *Woolgariana*, Borr., and *ramulosa*, Borr. (sometimes included in *Woolgariana*); and according to Babington, *S. Helix*, L.

Andersson has, in addition to the type (α *gracilis*, G. and Gr. = *S. purpurea*, Sm.), *Lambertiana*, Sm. (including *S. Woolgariana*, Borr.), and *S. Helix*, "L." (which is not the *S. Helix* of British botanists, but seems to be the same as *ramulosa*, Borr.).

Wimmer distinguishes the forms *eriantha*, *gracilis*, *Lambertiana*, *styligera*, *sericea*, and *furcata*.

As characterizing their varieties, British botanists lay stress upon the colour of the twigs and upon the form of the stigmas, points which are almost or quite ignored by the Continental salicologists. That the colour of the bark is not a constant character may be learnt from an examination of almost any living bush, when it will be seen that very frequently the coloration depends to a great degree upon exposure to the light. Moreover, from authentically named specimens it would seem that even British botanists do not attach so much importance to this feature as the descriptions would imply. Thus in Smith's herbarium *Lambertiana* (from Lambert himself), whose twigs modern writers describe as purplish, has in two of the flowering-specimens dark-coloured, and in the third, pale, bark.

As for the shape of the stigmas, I think that not much reliance can be placed on that supposed characteristic.

There remain therefore as primary characters, the form of the leaves, of the catkins, and of the capsules; and following Andersson's views three chief forms may be distinguished by those who wish to retain varietal names. These are:—

1. *gracilis* (or *genuina*), with slender catkins, small subovate capsules, and usually narrow leaves.

2. *Lambertiana*, with larger catkins, ovate-conic capsules, and larger leaves broad throughout (*Lambertiana*), or conspicuously broader above the middle (*Woolgariana*).

3. *ramulosa* (*S. Helix*, And., but since *S. Helix*, L., is dubious, the use of that name is not expedient), with rather stout capsules, and narrow, more elongate, and more acuminate leaves.

After examining an extensive series, the conclusion I come to is that while extreme forms admit of having one or other of these "varietal" names applied to them, the various modifications pass insensibly (as Boswell-Syme remarks) into each other, and that there are many specimens of which it is impossible to say with certainty to which variety they belong. I doubt therefore the expediency of retaining any varietal names.

Regarding Wimmer's forms (other than those mentioned above), there are amongst British specimens plants that might be referred to *eriantha* (catkins more hairy) though not in an extreme state, to *styligera* (ovary with a short style), and to *sericea* (young leaves more or less woolly).

×Salix rubra, *Huds.* (*S. purpurea* × *S. viminalis.*)

Since there has never been perfect unanimity amongst salicologists regarding Linné's *Salix Helix*, I have used for the hybrid between *S. purpurea* and *S. viminalis* Hudson's commonly accepted name of *S. rubra*. At the same time it is by no means clear that *S. Helix* should not be the name to be adopted.

Fries and Koch, and at a later period Andersson, thought that *S. Helix* was only a form of *S. purpurea*. Wimmer, on the other hand, believing that Linné could not have described under two names such a well-marked species (and one which he had seen in a living state) as *S. purpurea*, makes *S. Helix* a synonym of his *S. viminalis-purpurea*. Smith and his followers considered *S. Helix* to be a distinct species; and the later British botanists (with the exception of Babington, who places it under *purpurea*) agree in thinking it to be a variety of *rubra*.

Now, whatever doubt attends the Linnean plant—and it is certainly great,—there is none about Smith's. Both his descriptions and his specimens clearly indicate a hybrid between *purpurea* and *viminalis*, though much more closely related to the former than to the latter. It is to be noted, however, that many herbarium specimens named *Salix Helix* belong to *S. purpurea*.

As a rule, *S. rubra* seems to show a smaller range of variation than most other hybrids, and hence its division by Grenier into two chief varieties—*viminaloides* and *purpureoides*—has some claim for consideration. But this supposed constancy of form is perhaps more apparent than real; and is due, in the first place, to the fact that in many cases the plants have been derived from cuttings, and not from seeds; and, in the second, to the leaves of both parent species being of the linear-lanceolate type, and hence not affording so much scope for difference in outline in the hybrid.

Var. *viminaloides* (or *rubra genuina*) is distinguished by its longer and narrower lanceolate leaves, more or less pubescent below, at least when young, and with the margins more or less revolute; by the paler and more hairy ♀ catkins; and by the longer style and stigmas. The petioles of the leaves are described as longer, but in this and other points there is variability. In some British books the filaments are said to be free except at the base; but in the same catkin filaments almost free or united to any point between the base and the apex may be found.

Var. *purpureoides* (which includes *Forbiana*, Sm.) has leaves broader at the middle, with flat and more or less serrated margins and more entirely glabrous surfaces; darker-coloured and less hairy catkins, and more obtuse capsules with shorter styles and thicker stigmas. The leaves are described as more shortly petioled than in *viminaloides*, and Continental examples often show this, but in authentic examples of the British *Forbiana* the reverse is the case.

Andersson adopts Grenier's division into two varieties; but Wimmer, who distinguishes several forms, does not: and since in places where *rubra* occurs as a spontaneous hybrid, plants combining the characters of *viminaloides* and *purpureoides* may be found, I think that it is not desirable to maintain varieties in this hybrid more than in others. Wimmer's forms are b. *Forbyana*; c. *sericea*, Koch (=*S. eleagnifolia*, Tausch), with the leaves clothed below with silvery-white hairs—a form which I have seen in Perthshire; d. *macrostigma*; and e. *angustissima*. These and other described modifications show that though, for

the reasons given above, there appears to be a constancy of form in *Salix rubra,* a series of conditions can be found connecting *viminalis* and *purpurea*, the chief grades being *sericea*, *rubra*, *Forbiana*, and *Helix* (of Smith).

A Perthshire plant, otherwise intermediate in its characters, has rather remarkable stamens. Whilst the filaments are usually connate half-way or to near the top, in some of the flowers one or both are divided at the apex—the division being of unequal length, and presenting the appearance of a stamen with 2, 3, or 4 irregular branches. It is to be noted that as these branches form acute and not obtuse angles with the main filament, this does not seem to be a true case of what Hayne has termed cladostemmy.

× SALIX SORDIDA, *Kern.* (*S. purpurea* × *S. cinerea.*)

As the name *S. Pontederana*, Schleich., is, according to A. Kerner, dubious, having been applied to hybrids of *S. purpurea* with several of the *Capreæ*, it appears advisable to use Kerner's name of *S. sordida* for the hybrid with *S. cinerea*. Andersson, indeed, retains the name *Pontederana*; but he makes it include the hybrids formed not only with *S. cinerea*, but with *S. Caprea*, *S. grandifolia*, and *S. aurita*, since he thinks that there is no sure method of separating them. As, however, he has not united these species, it is scarcely justifiable to unite the hybrids if it is at all possible to distinguish them; and he himself has kept them separate as varieties.

Of *S. sordida* (whose synonyms are *S. subpurpurea-cinerea*, Kern., and *S. cinerea-purpurea*, Wimm.), Andersson, following Wimmer, describes two modifications, viz.: 1. *cinerascens* (nearer *S. cinerea*), and 2. *glaucescens* (approaching *S. purpurea*, and probably *S. Pontederana* of Koch). It is to be noted, however, that in other respects Andersson's and Wimmer's descriptions do not tally in every particular; and that, moreover, Wimmer's published specimens do not always altogether agree with his descriptions, as, for example, in the length ascribed to the pedicel of the capsule.

In the Woody Island near Perth, where both *S. purpurea* and *S. cinerea* abound, *S. sordida* appears to be not uncommon. But while forms quite intermediate between the parent species occur, the majority of individuals are in character much nearer *S. cinerea* than *S. purpurea*—so near, in fact, that in the absence of

flowers, some of them would with difficulty be discriminated from *cinerea* otherwise than as slight modifications.

As belonging to *Salix sordida* I put all plants which, however like *cinerea* they may be, have the filaments of the stamens more or less united to each other. Connate filaments may, according to Wimmer, be distinguished from cladostemmic ones by the branches forming an acute and not an obtuse angle; and one of the best characters of hybridization with *S. purpurea* is the presence of connate stamens.

In these Woody Island plants an extreme degree of connation is rare. Frequently the filaments are united for a little way above the base only; but in the same catkin free, slightly united, and more distinctly connate stamens may all be found—a phenomenon which may be seen in *S. rubra* and other hybrids of *S. purpurea.*

Other points in which these *cinerea*-like plants are variable are the shape, colour, and pubescence of the leaves, stoutness and pubescence of the twigs, shape of the catkins, and colour of the anthers. In all these particulars they approach, or recede from, *S. cinerea* by almost imperceptible gradations. Probably, as Wimmer suggests, the *cinerascens* modifications of *S. sordida* have a somewhat different origin from those which are nearer *S. purpurea*, having been possibly produced by *purpurea* ♀ × *cinerea* ♂, or, what seems more likely, by the crossing of *sordida* with *cinerea.*

The ♀ of the *cinerea*-like forms is a much more difficult plant to distinguish than the ♂, since of course we have not the assistance afforded by the connate filaments. I have indeed found some plants whose catkins are so like those of *cinerea*, that it is only by the resemblance of their leaves and habit to some ♂ plants of *sordida* that they can be referred to that species.

In addition to the Woody Island plants, I have seen specimens from a ♂ bush found at Dalmarnock, on the Tay above Dunkeld, by Mr. C. M'Inotsh, and have found both sexes on the banks of the Tay below Perth.

Another willow from the Woody Island I at present include under *S. sordida* (as var. *rubella*), though I am inclined to suspect that it may be a cross of *S. rubra* (with which it grows) and *S. cinerea* (i. e. *S. purpurea* × *S. viminalis* × *S. cinerea*). In its leaves and habit is is near *S. purpurea*, but has free stamens. The very beautiful catkins are small or moderate in size; the unopened anthers orange-red, but when burst yellow from the

pollen, and finally, when empty, fuscous; leaves oblanceolate, dark green and shining above, very glaucous below, soon quite glabrous, but at first more or less pubescent with brownish hairs; branches slender and straight, glabrous almost from the first.

× Salix dichroa, *Döll.* (*S. purpurea* × *S. aurita.*)

To this hybrid belongs the willow published by Mr. Leefe (*Sal. Exs.* iii. No. 59) as "*Salix Pontederana* ? Schl.," and found by him at Rothbury in Northumberland.

S. dichroa is very similar to *S. sordida*; but the *cinerea* element in the latter is replaced by *aurita*. Mr. Leefe, who describes his plant as "a small shrub with declining branches," has published ♂ specimens only; and these agree so sufficiently well with examples of the hybrid issued by Wimmer and by Kerner, that there can be no doubt about their identity. Mr. Leefe found in the same place a willow which he thought "*might* be the female;" but the catkins are much deformed, being, in fact, hermaphrodite monstrosities. Of this I have seen one catkin only; and from it not much can be learnt. The leaves, however, resemble those of the ♂ plant, but are rather nearer in character to *S. aurita*.

× Salix Doniana, *Sm.* (*S. purpurea* × *S. repens.*)

Salix Doniana was founded by Smith ('English Flora,' iv. p. 213. 47) on a willow "sent from Scotland, as British, by the late Mr. George Don;" and though it has continued to be retained in our floras, it is probable that the majority of the later botanists had come to the conclusion that its claims to be considered British were very slight. For my own part I had, at the time that this paper was read, decided to omit it from the list of British Willows, because, amongst other reasons, it had not come directly from Don into Smith's hands, but from Borrer, who received it from George Anderson, and in the transmission from hand to hand some particulars of its occurrence might have been accidentally lost. But I have now the pleasure of restoring it to a place in the list, having, during the past summer, found undoubtedly wild specimens on the banks of the river Tummel, near Pitlochry, in Perthshire.

The plants I found were growing with *S. purpurea*, and in the neighbourhood of *S. repens*. They are distinctly intermediate in character between the parents. The following notes were taken

from living specimens:—Bush about 18 inches high. Bark of the twigs shining brownish green, of the shoots redder and slightly downy. Some of the upper leaves subopposite, after the manner of *Salix purpurea*. Leaves dull, rather dark green with white hairs above; below dull pale green, with more copious long white hairs; margin cartilaginous, slightly incurved, very finely and remotely serrate, with reddish glands; veins pellucid, the chief veins impressed on the upper surface and raised on the lower. In shape the leaves are similar to those of the *S. purpurea* amongst which it was growing (*i. e.* similar to *S. Doniana*, Sal. Wob. t. 85). Catkins (♀) rather old, lateral, on a peduncle having three or four small leaves. Scales ovate spathulate, rounded at the apex, upper half black, with long white hairs. Ovary ovate conic, blunt; style distinct, though short; stigmas very short, thick, and rather broad, semi-bifid; ovary white pubescent, on a pedicel about as long as the linear pale yellow nectary.

Though the ♀ plant only has been found in Britain, both sexes are known in Central Europe, where *S. Doniana* is widely distributed. Andersson mentions four forms or varieties, viz. *α. latifolia*, *β. lingulata*, *γ. linearis*, *δ. leiocarpa*. Wimmer describes six forms, but does not give them names. The filaments of the ♂ flowers are connate at the base only, or for a third or half their length.

DESCRIPTION OF THE PLATES.

Plate IX.

A diagrammatic statement of the different views regarding the number of British Willows held at various periods between 1762 and 1886. The dates given are those of the publication of the Works taken as representing the views of the period (see p. 334). The shaded columns indicate the number of *numbered* "species," and are divided into three portions—dark, medium, and light. The dark shaded portion shows the number of true species; the medium shade the number now recognized as hybrids; and the light shade the number of those once supposed to be species, but now considered to be either merely forms or to have no claim to be admitted as British. In the last column is given the estimate for 1890 of the true species (dark shaded) and of the hybrids (medium shaded) which have been found in Britain.

PLATE X.

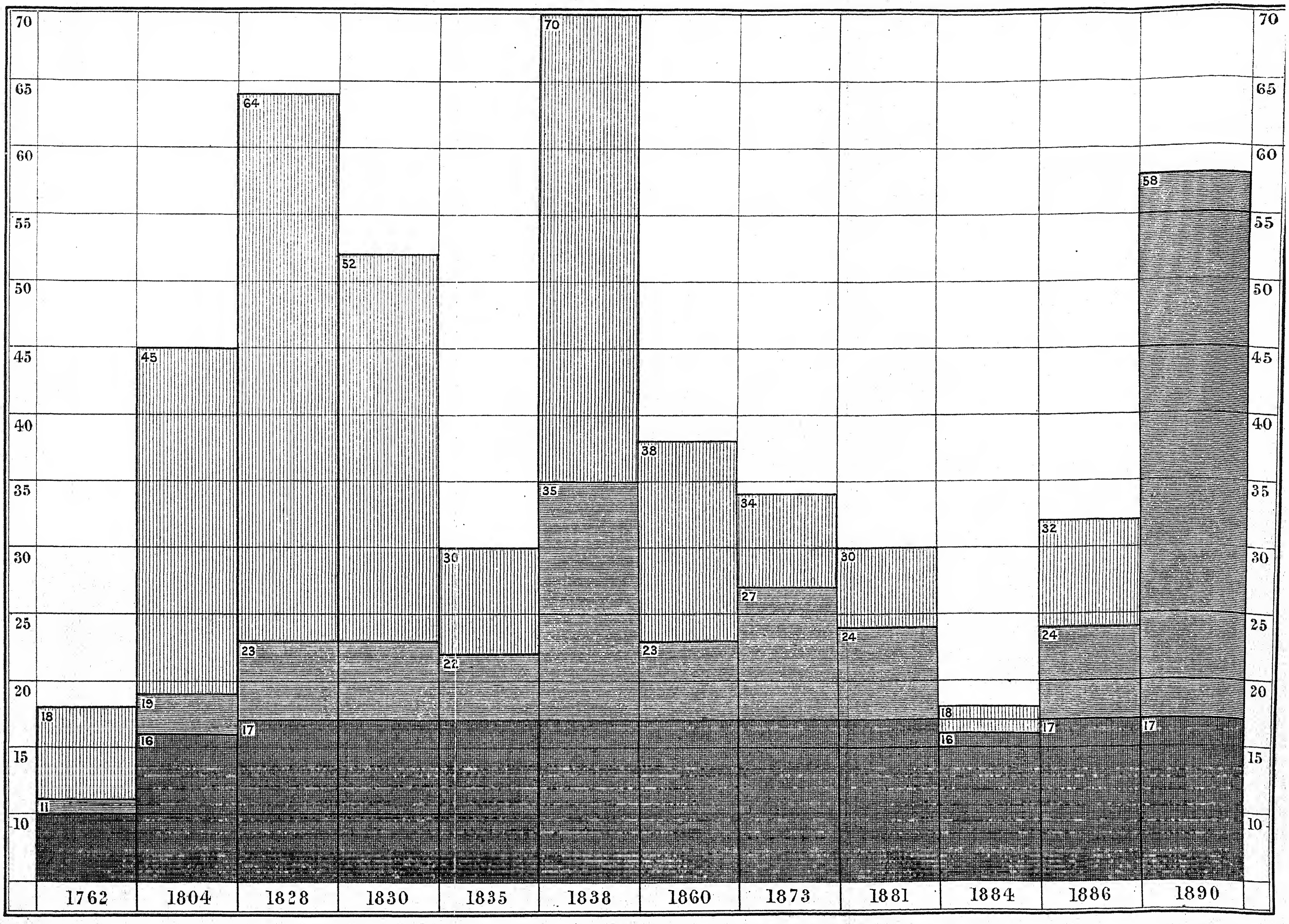
A diagram to illustrate the various ways in which compound hybrids (*i. e.* hybrids in whose parentage are included more than two species) may be formed.

PLATE XI.

A diagram showing the relationship of both Tribes and Species as regards the British simple hybrid Willows. The larger circles represent the Tribes, the smaller circles the Species, and the lines connecting the latter indicate that Hybrids between these species have been found in Britain. The circle containing the Tribe Diandræ has been divided into four sections to show the altitudinal range of the species, since that limits to some degree the number of hybrids. Section I. is strictly lowland, the solitary species in it not ascending above 1000 feet above sea-level. Section II. includes species which, while most common in the low grounds, yet ascend into the alpine region of Section III. Section III. contains the species which rarely, if ever, descend below 1000 feet, and most frequently occur only at a much greater altitude. Section IV. contains two species which properly belong to Section III., but which occasionally, though very rarely, descend far below the 1000-feet line. The Tribes Pleiandræ and Synandræ include lowland species only.

INDEX.

The Tribes are printed in SMALL CAPITALS, the groups in *italics*, the species and hybrids of *Salix* in Roman type, and unnamed hybrids are doubly indented.



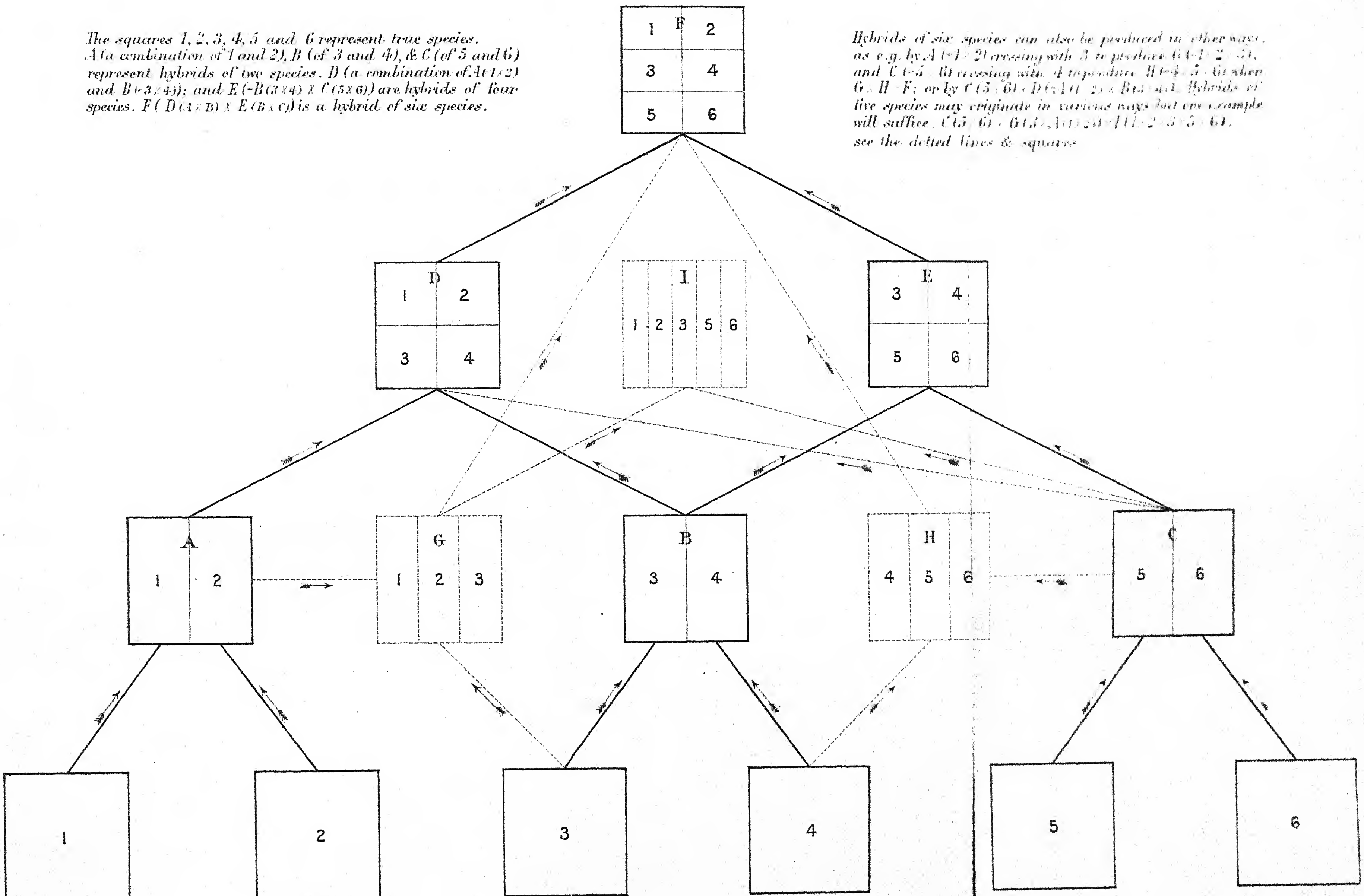
B.W. inv. et del.

Mintern Bros. lith.

Linn. Soc. Journ. Bot. Vol. XXVII. Pl. 10.

The squares 1, 2, 3, 4, 5 and 6 represent true species. A (a combination of 1 and 2), B (of 3 and 4), & C (of 5 and 6) represent hybrids of two species. D (a combination of A (=1×2) and B (=3×4)); and E (=B (3×4) × C (5×6)) are hybrids of four species. F (D (A×B) × E (B×C)) is a hybrid of six species.

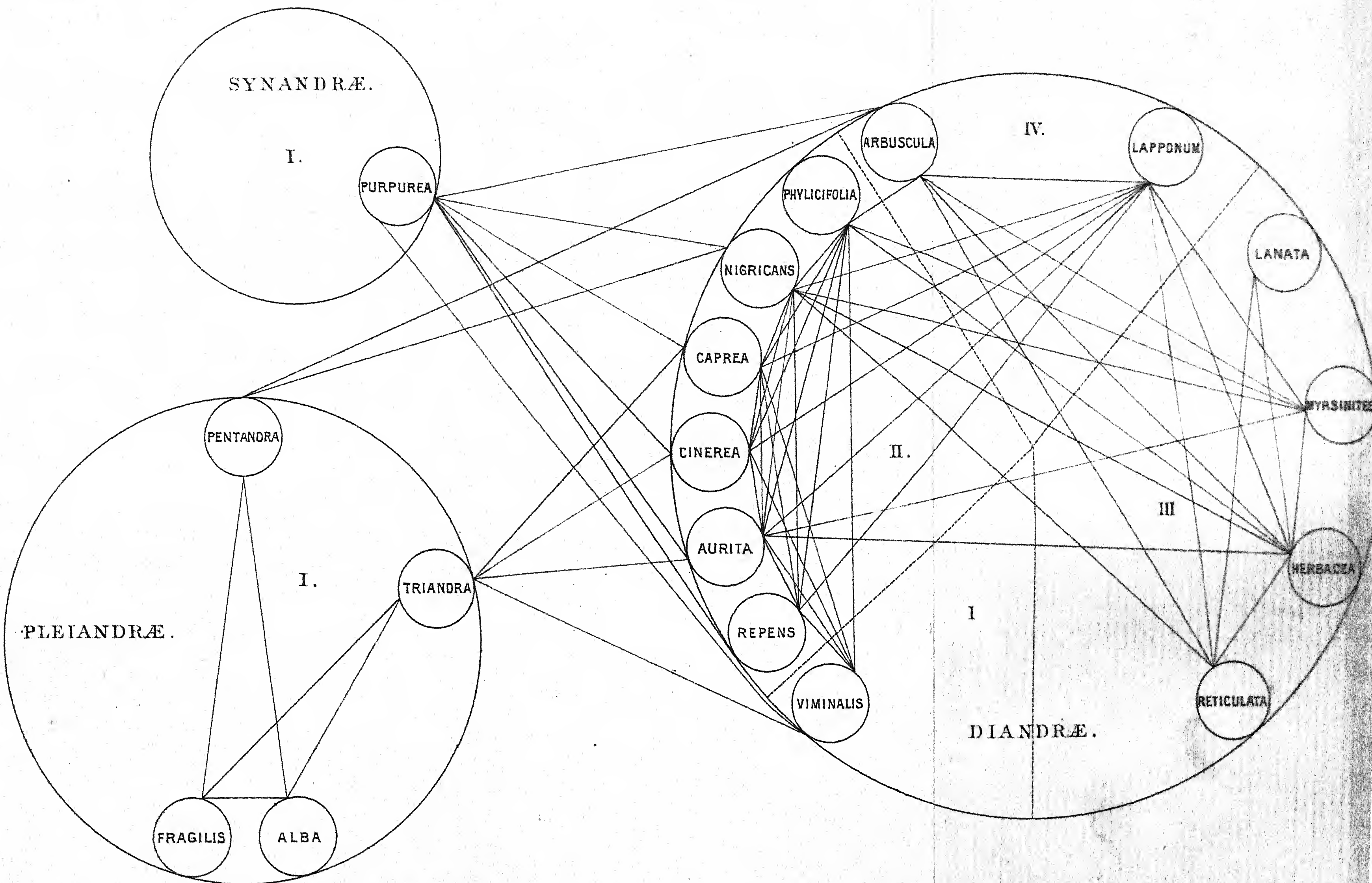
Hybrids of six species can also be produced in other ways, as e.g. by A (=1×2) crossing with 3 to produce G (=1×2×3), and C (=5×6) crossing with 4 to produce H (=4×5×6) when G×H=F; or by C (5×6) × D (=A (1×2) × B (3×4)). Hybrids of five species may originate in various ways but one example will suffice, C (5×6) × G (3×A (1×2)) = I (1×2×3×5×6). see the dotted lines & squares



B. W. inv. et del.

DIAGRAM OF THE PEDIGREE OF HYBRIDS.

Mintern Bros. lith.



The larger circles indicate the three tribes;
the smaller circles the species.
The lines connecting the species indicate that
these are known to form hybrids.

The Sections indicate:
I, not ascending above 1000 feet.
II, ascending from below 1000 feet to above 2000 feet.
III, rarely if ever descending to 1000 feet.
IV, occasionally descending below 1000 feet.

B.W. inv. et del.

Mintern Bros. lith.

DIAGRAM OF THE HYBRIDS OF THE BRITISH SPECIES OF SALIX.

Life-History of a Stipitate Freshwater Alga. By GEORGE MASSEE. (Communicated by the Secretary.)

[Read 5th December, 1889.]

(PLATE XII.)

THE genus *Dictyosphærium* was established by Nägeli * for the reception of a very remarkable freshwater alga—*Dictyosphærium Ehrenbergianum*, Näg., found floating in ditches near Zurich.

The generic diagnosis is accompanied by good figures and an excellent description of the leading morphological features of the plant.

The following closely allied "species" are all that are known up to the present:—

DICTYOSPHÆRIUM EHRENBERGIANUM, *Näg. Einz. Alg.* p. 73, t. ii. E; *Rab. Alg. Eur.* sect. iii. p. 47, f. 20 (dextra); *Wolle, Alg. U. States*, p. 186, pl. clvi. ff. 29–30; *Cooke, Brit. Alg.* p. 20, pl. ix. f. 1.

DICTYOSPHÆRIUM RENIFORME, *Buln. in Hedw.* ii. p. 22, t. i.

* Gatt. Einzel. Algen, p. 72, t. ii. E (1848).

f. 6; *Rab. Alg. Eur.* sect. iii. p. 47, f. 20 (sinistra); *Wolle, Alg. U. States*, p. 186, pl. clvi. f. 28; *Cooke, Brit. Alg.* p. 21, pl. ix. f. 2. Exsicc. *Rab. Alg.* no. 789.

DICTYOSPHÆRIUM HITCHCOCKII, *Wolle, Alg. U. States*, p. 186, pl. clviii. f. 12.

DICTYOSPHÆRIUM PULCHELLUM, *Wood, Alg. N. Amer.* p. 84, pl. x. f. 4. Exsicc. *Wittrock et Nordstedt, Alg. Exs.* no. 239.

Two species are common to Europe and North America, whereas *D. Hitchcockii* and *D. pulchellum* have hitherto been observed in the last-named country only.

The species are all very similar in general appearance, and under a low magnifying-power resemble minute hyaline spheres studded with brilliant green spots.

During the past summer a *Dictyosphærium*, which appears to agree with the spherical-celled variety of *D. Ehrenbergianum* figured by Cooke *, has been fairly common in the open-air tank at Kew, mixed with *Spirogyra* and *Cladophora*. Although the tank has been regularly searched for Algæ for some years, no trace of a *Dictyosphærium* was seen before the present season. Last year the same tank was covered for some time with a dense orange-coloured scum consisting of the rare alga *Sphæroplea annulina*, Ag.; whereas this year not a trace of this alga has been seen, although myriads of its oospores must have sunk into the mud. In connection with the last-named plant, it may be mentioned that just before its appearance the tank had been dry for some time for the purpose of cleaning and repairing. I stocked two jars with *Sphæroplea* obtained from the tank, one of which, owing to neglect, became dry during the summer, and remained in that condition for a week. The second has always contained water, and up to the present time no trace of *Sphæroplea* has appeared in it; whereas in the jar that became dry, the *Sphæroplea* appeared in quantity about ten days after it had been filled up with water. From the above statement it would seem that the oospores of *Sphæroplea* benefit by a period of desiccation: as to whether this condition is absolutely necessary remains yet to be proved, and possibly similar conditions may to some extent influence the sudden appearance or disappearance of other forms of freshwater Algæ.

* Brit. Alg. pl. ix. f. 1, *c*.

In the earliest stage, the *Dictyosphærium* cannot be distinguished from a small specimen of *Pleurococcus vulgaris*, Meneg. The cell-wall is at first about 1μ thick, and consists of cellulose, becoming bluish-violet on the application of chlor-iodide of zinc. As the cell increases in size, but before it shows any signs of fission, the cell-wall increases in thickness, and at the same time becomes mucilaginous, with indications of stratification, and in this condition the cellulose reaction is confined to the innermost firm layer, which corresponds to the original cellulose wall, the peripheral mucilaginous layer becoming brown with a solution of iodine, and behaving in many respects more like protoplasm than any modification of cellulose. The chlorophyll is of a very bright yellow-green, but the presence of chromatophores was not satisfactorily determined. The application of hæmatoxylin reveals the presence of a nucleus, especially after the specimen has been treated with absolute alcohol for a few minutes. When the chlorophyllose portion of the spherical cell attains a diameter of about 6μ, it divides simultaneously into four equal parts by two septa developed in two planes at right angles to each other. The septa do not extend quite to the centre of the mother-cell; consequently the four lobes into which it divides remain organically united in the centre by thin portions about 2μ diameter, and may be compared to four plums united by their stalks in the centre of the group. The mucilaginous portion of the mother-cell-wall does not divide along with the chlorophyllose portion, but continues to increase in quantity, and envelops the segments in a continuous hyaline stratum. After segmentation of the mother-cell the segments, at first more or less angular, become spherical, still remaining attached by their central stalk-like portions, which continue to increase in size until they attain a length of about 10μ; these stalk-like portions are usually perfectly hyaline, with a very minute lumen, which under a high magnifying-power is seen to contain granular fragments scattered here and there, which are sometimes coloured green.

In old plants the stem-like connecting portions have the lumen completely obliterated. By the time the connecting portions have reached the length of about 10μ, the chlorophyllose portions of their enlarged apices have respectively assumed the appearance and size of the original mother-cell immediately before segmentation; each swollen apical segment of the cell is now surrounded by its own mucilaginous coat, the whole being

enclosed in the mucilage secreted by the unsegmented mother-cell. There is a total absence of septa, and the cell now resembles a pair of dumb-bells crossing in planes at right angles to each other, and enclosed in a hyaline sphere of mucilage.

When the above-described stage of development has been reached, each of the four swollen apices becomes segmented into four portions; but this process differs from the method described as taking place in the mother-cell, in the segmentation into four lobes not being simultaneous. In the first instance, each swollen apical portion is divided by a cell-wall lying in the same plane as the long axis of its stem; the two segments diverge, each becoming stipitate, the stem-like portions starting from the apex of the original stem and forming a dichotomy. When the stems supporting the two segments have attained a length of about 8μ, their swollen chlorophyllose apices again divide into two equal portions, by septa developed in a plane at right angles to those of the previous generation; the stems continue to increase in length and diverge as before, forming a second dichotomy. If each of the first four segments has divided into four portions, the cell now consists of sixteen globose chlorophyllose portions terminating an equal number of hyaline stem-like achlorophyllose threads radiating equally in all directions from a central starting-point, each of the four primary arms bifurcating, and each arm in turn giving origin to two others by a second bifurcation, the ultimate arms bearing at their free tips the chlorophyllose portions of the cell. The third time of division sometimes terminates the vegetative activity of the cell, but usually the segments divide in a similar manner four or five times, so that the cell consists respectively of thirty-two or sixty-four segments. As a rule all the swollen apices divide into two segments each, in rare instances three are produced, or no segmentation takes place, when the geometrical symmetry of the cell is disturbed and a departure from the typical sphere results. At the period of segmentation of any given generation of swollen tips, the mucilaginous cell-wall surrounding each loses its individuality, and mingles with the general sphere of mucilage surrounding the complex cell.

The vegetative phase terminates abruptly, and is at once followed by that connected with reproduction. The chlorophyllose masses of protoplasm terminating the ultimate dichotomes become slightly contracted, at the same time the

chlorophyll becomes aggregated on one side of the minute spheres of protoplasm, which externally exhibit rotatory movements, and finally escape from the cells as globose zoospores about 4μ in diameter, furnished with a minute knob-like projection on the colourless side of the sphere, from which originates two exceedingly slender cilia, each about 12μ in length.

During the period occupied in the differentiation of the protoplasm, previously concerned with vegetative work bearing on the well-being of the individual, into zoospores, the mucilaginous wall, as also the innermost firm cellulose portion belonging to each one of the apical swollen portions, has lost its individuality and blended with the common sphere of mucus. The liberated zoospores are all of equal size, and after remaining active for about two hours become stationary, resorb their cilia and become surrounded by a wall of cellulose, during which change the chlorophyll becomes equally diffused throughout the cell, which is now in a condition to recommence the vegetative phase by fission. It is certain that many succeeding generations are produced by the above method during the summer months; as to whether the ultimate zoospores become encysted, and in this condition pass the winter months, I have unfortunately been unable to determine.

Although the plant under consideration is technically unicellular, it nevertheless approaches very closely various generic types of freshwater algæ that are probably, out of deference to historic prejudice, considered multicellular.

The most prominent morphological feature presented by the species of *Dictyosphærium* is the repeated division of the original spherical cell into portions radiating equally from a central point, and in the persistent concentration of the protoplasm at the tips of the repeatedly dichotomous radiating stem-like portions. In the last feature the present genus at first sight appears to be unique, but the difference is really but one of degree. The spores of numerous, in fact of most species of multicellular algæ, both freshwater and marine, and also of many unicellular forms, on germination, produce a distinctly stipitate plantlet, due to the protoplasm remaining concentrated at the apex and leaving a colourless, thin, empty portion of the cell-wall behind in the form of a stem-like base, which is usually discoid at the point of attachment. Such forms differ from the initial stage of *Dictyosphærium* in the spore not at once dividing into four, but remaining

intact, and thus forming one growing-point only instead of four. In all multicellular algæ the stem-like base eventually disappears, but in the following genera, which are all freshwater forms, the attenuated and often elongated basal portion is permanent, hence the species are described by systematists as being "stipitate":—

Characium, A. Braun; *Hydrianum*, Rab.; *Sciadium*, A. Braun (*Sciadium* is included as a section of the genus *Ophiocytium* by Rabenhorst); *Peroniella*, Gobi; *Actidesmium*, Reinsch; *Dictyosphærium*, Näg.; *Cœlastrum*, Näg.; *Dimorphococcus*, A. Braun; *Mischococcus*, Näg.; *Cosmocladium*, Bréb.; *Dactylococcus*, Näg.; *Oocardium*, Näg.

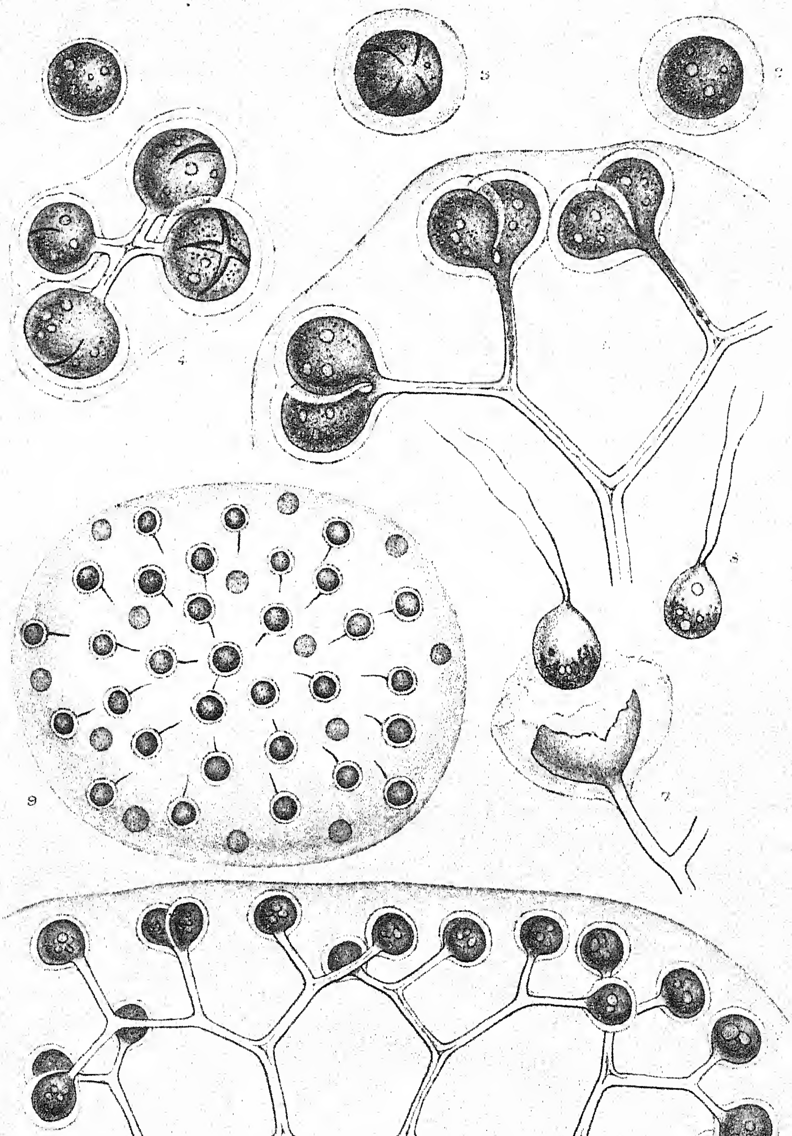
The following genera form a transition from permanently stipitate to sessile forms:—*Apiocystis*, Näg.; *Hydrocytium*, A. Braun; *Codiolum*, A. Braun.

In the *Diatomaceæ* stipitate genera are numerous, but the stem differs from the type already described in being from the first solid, and not an attenuated condition of the cellulose cell-wall, as in the stipitate forms of freshwater algæ.

EXPLANATION OF PLATE XII.

Fig. 1. *Dictyosphærium Ehrenbergianum*; earliest stage of the vegetative cell. × 600.

2. The same, at a later stage, with a mucilaginous sheath. × 600.
3. The same, showing the earliest stage of fission. × 600.
4. The same, showing the first four divisions of the cell in the act of dividing. × 600.
5. Peripheral portion of same, showing the swollen apices dividing in a dichotomous manner. × 600.
6. Portion of same, showing the extent of division undergone by one of the four primary segments of the first cell. × 350.
7. Portion of same, showing the escape of a zoospore from its parent cell × 1200.
8. Zoospore of same. × 1200.
9. Surface view of an individual cell involved in mucus, at end of vegetative phase. × 200.



G.M. del.
Berjeau & Highley lith.
West, Newman imp.

DICTYOSPHÆRIUM EHRENBERGIANUM, *Näg.*

On the Systematic Position of the Dictyotaceæ, with special reference to the Genus *Dictyopteris*, Lamour. By THOMAS JOHNSON, B.Sc. (Lond.), University Scholar in Botany, Demonstrator of Botany in the Normal School of Science. (Communicated by D. H. SCOTT, M.A., Ph.D., F.L.S., Assistant Professor of Botany in the Normal School of Science.)

[Read 19th December, 1889.]

(PLATE XIII.)

THE *Dictyotaceæ*, of which the genus *Dictyopteris*, Lamour. (*Halyseris*, Ag.), is a member, occupy, at the present time, much the same sort of position in the *Phæophyceæ* (Brown Seaweeds) that the *Characeæ* do in the Green Algæ. Thus Falkenberg, in his important paper on Algæ in Schenk's 'Handbuch' (Bd. ii. p. 169), divides the chlorophyll-containing Thallophytes as follows:—

Class I. **Florideæ.**

(? *Dictyotaceæ.*) Marine Thallophytes, with unknown process of fertilization; systematic position still quite unknown. Agreeing with the Florideæ in the formation of motionless tetraspores and spermatia, joining on to the Melanophyceæ in their vegetative organs.

Class II. **Algæ.**

Subclass I. MELANOPHYCEÆ (*Phæophyceæ*). Including *Fucaceæ*, *Cutleriaceæ*, *Phæosporeæ*, *Tilopterideæ*.

Subclass II. CHLOROPHYCEÆ.

Class III. **Diatomaceæ.**

Class IV. **Schizophyceæ.**

Messrs. Bennett and Murray, in their 'Handbook of Cryptogamic Botany' (p. 255), would retain the *Dictyotaceæ*, until more is known of the process of fertilization, as an aberrant order of *Phæosporeæ*. Prof. Vines, in his article "Vegetable Kingdom" in the 'Encyclopædia Britannica' (p. 127), places the *Dictyotaceæ* between the *Cutleriaceæ* and the *Fucaceæ*, a position in which I was at first inclined to place them. My object in this paper is to remove the *Dictyotaceæ** from their anomalous position, on the ground of my own observations, more espe-

* Cohn (Schenk, *op. cit.* p. 233) regarded the *Dictyotaceæ* as true Florideæ.

cially on *Dictyopteris polypodioides*, and those of Reinke on the *Tilopterideæ*, and to give the Order a definite place in the Phæophyceæ.

Structure of the Thallus.

The thallus of the Dictyotaceæ is built up on a plan which is essentially different from that on which the thallus of the Florideæ (excluding the Bangiaceæ) is formed. In the Florideæ, according to Schmitz *, the thallus consists of a system of branching monosiphonous filaments, each filament growing by an apical cell the segments of which never divide by median longitudinal or median transverse walls, only by a gemmation of daughter-cells which themselves often become the apical cells of new filaments. In the Dictyotaceæ, on the other hand, the thallus is distinctly *parenchymatous*. The single apical cell, found throughout life in *Dictyota*, and furnishing in *D. dichotoma*, as is well known, the clearest example of dichotomy, is present at an early stage in *Taonia* and *Dictyopteris*, being soon replaced, in *Dictyopteris*, by an initial group or marginal row of cells, the segments of which divide by transverse and longitudinal walls, as in ordinary parenchymatous cells. In *Dictyopteris* the thallus becomes, by a tangential division of the segments, generally two-layered except in the region of the midrib, the production of which is, as Falkenberg † states, due to a repetition of localized tangential divisions. It is of interest to note that the 8–10 layers of which the midrib may consist are arranged very regularly (Pl. XIII. fig. 1), and not, as figured by Harvey, Kützing, and others, without any order. Continuity of protoplasm may be shown, by Hoffmann's blue and similar reagents, through the transverse walls of the elongated central cells of the midrib and stalk. This stalk in *Dictyopteris* is due to the disappearance from the basal part of the midrib of the general lamina of the thallus. The transition from the flattened midrib to the subcylindrical stalk is gradual. Examination of the stalk by transverse and by longitudinal sections shows that it grows in thickness, and is strengthened by the activity of a meristematic layer, an incomplete cambial zone. The outermost layer, the epidermis or limiting tissue, is the meristematic layer giving off, on its inner side only, by tangential divisions

* F. Schmitz, "Unters. ü. d. Befruchtung d. Florideen" (Sitz. d. k. Akad. d. Wiss. z. Berlin, 1883 pp. 215–258), and Ann. Mag. Nat. Hist. 1884, vol. xiii. (ser. 5) pp. 1–29 and 80–96.

† Falkenberg, in Schenk's Handb. ii. p. 232.

radial rows of cells (figs. 2, 3), reminding one of the mode of procedure of the extrafascicular cambium of the stem of *Dracæna* and other arboreous Liliaceæ. Interruption of the cambial zone occurs at the diametrically opposite scars due to the atrophy of the thallus lamina. The occurrence of secondary thickening of this nature in a seaweed and in one of the Dictyotaceæ is, more especially from a systematic point of view, of considerable interest, only two other cases of the kind being known. It is well known that secondary thickening very much as in *Dictyopteris*, but with a deeper-seated meristematic layer, takes place in the stalk of the Laminariaceæ. Reinke, in 1876, showed that in the stalk of *Fucus vesiculosus* * secondary thickening by the activity of a cortical cambial layer takes place, twenty, or more, tangential layers being thus added; to him also belongs the credit of first finding secondary thickening in *Dictyopteris* †, but he failed to observe the special cambial layer, and did not enter into the secondary thickening in full detail. Strange to say, there is no reference, in any subsequent observations, to Reinke's on *Fucus vesiculosus* ‡ or on *Dictyopteris*. Seeing the stalk thicker than the midrib, my impression was, before making any sections, that possibly the thickening was due to the interpenetration of hypha-like prolongations of the lower cells of the midrib, a mode of thickening found in the basal part of the thallus of *Ulva*, *Bangia*, *Porphyra*, and in the *Fucaceæ*. Growth in thickness, as it occurs in *Dictyopteris* §, is a well-marked Phæophycean character, not to be met with in the *Florideæ*.

Reproduction.

A. *Vegetative (or asexual).—Tetraspores.*

The presence of asexual reproductive bodies in the form of cruciate tetraspores is considered a strong Floridean affinity. The *Dictyotaceæ* are not alone amongst *Phæophyceæ* in the possession of such bodies. Reinke, at the beginning of this year

* Reinke, Jahrb. f. wiss. Bot. x. 1876, p. 333.

† Reinke, "Entwicklungsg. Unters. üb. d. Dictyotaceen d. S. v. Neapel," in Nov. Act. Ac. Leop.-Carol. vol. xl., 1878.

‡ Bower and Vines, in 'Practical Botany,' pt. ii. p. 51, repeat Reinke's observations.

§ Judging from the specimens in the Herbarium of the Natural History Museum, I believe many species of *Zonaria* will, on examination, show similar thickening.

(1889), showed that the asexual non-motile spores of the *Tilopterideæ* * (a group placed by all phycologists in the *Phæophyceæ*) are *quadrinucleate*, and in reality potential *tetrasporangia*. At the same time that this discovery helps one to withdraw the *Dictyotaceæ* from the *Florideæ*, with which Falkenberg hesitatingly placed them, it does not of itself render the opinion entertained by some observers, that the *Dictyotaceæ* lead on from the *Phæophyceæ* to the *Florideæ*, untenable. In *Dictyopteris polypodioides* the tetrasporangia are in sori arranged along the midrib, the tetrasporangia in *Dictyota dichotoma* being scattered over the surface of the thallus.

B. *Sexual.*—i. *Antheridia.*

Thuret, in 1855, discovered and fully described the antheridia in *Dictyota* †, tracing them from origin to maturity. It would not be correct to say that, up to the present, the antheridia of *Dictyopteris* have not been observed. Beyond the statement in 'Études Phycologiques,' that the antheridia in *Dictyopteris*, *Taonia*, *Padina*, and *Spatoglossum* are of the same type as those of *Dictyota*, I have been able to find no description or figures of those of *Dictyopteris* ‡. They occur both alongside the midrib and scattered over the general thallus-surface on each side of it (Pl. XIII. fig. 4). Each antheridium, of no definite outline, consists of 3 to 100 transparent adjacent superficial cells of the thallus. These cells acquire clear granular contents, come to project a little above the thallus-surface, and divide tangentially into small stalk-cells and large outer cells. The contents of the latter undergo repeated divisions until there is formed a small-celled tissue of compact cubical cells, each containing a potential "pollinoid," the whole being compared by Thuret in *Dictyota* to the young antherozoid mother-cells in the antheridium of a moss. Each antheridium has, in *Dictyopteris*, only a feebly developed involucre, quite insignificant compared with that of *Dictyota* (figs. 1, 5). At maturity the outer wall of the antheridium is ruptured along one side and raised, allowing the male cells to escape into the surrounding water. Thuret § says "the corpuscles which escape from the cells of the antheridium in *Dictyota*

* Reinke, in Bot. Zeit. t. ii. & iii. nos. 7–9 (1889).

† J. Thuret, in Ann. d. Sc. Nat. 4e sér. Bot. t. iii. (1855).

‡ Agardh, 'Species Algarum,' i. p. 115 (1848).

§ Thuret, *op. cit.* p. 11.

dichotoma spread out in the water in the form of hyaline globules like the spermatia which escape from the antheridia in the *Florideæ*, and they seem, like them, non-motile." The male corpuscles of *Dictyopteris polypodioides* are not spherical, generally pear-shaped, sometimes irregular in outline, and consist of well-marked granular, not homogeneous, protoplasm, being different from the spermatia of *Florideæ*, as quite recently more accurately described by L. Guignard *. On one occasion, between 10 and 11 in the evening, I was examining the antheridia microscopically, when I saw one from which the male corpuscles were escaping and exhibiting movements of such a nature as to give me the impression that they were ciliated. Subsequent examination, again and again repeated in different ways (and with a $\frac{1}{15}$-mm. immersion-objective), of preserved material has strengthened my conviction that the male corpuscles of *Dictyopteris* are not pollinoids, like those of the *Florideæ*, but antherozoids, essentially like those of *Cutleriaceæ* and *Fucaceæ*. Fig. 10, pl. v., representing a developing antherozoid of *Fucus vesiculosus* in Guignard's paper already quoted †, is very like stages I have seen in the developing male corpuscle of *Dictyopteris*. Still I must ask to be permitted to reserve a final expression of opinion on the presence of cilia until I have made a detailed examination of fresh material ‡.

ii. *Oogonia.*

May I call attention to the great importance of remembering that though the undivided spores in *Dictyota* are in sori, they are in *Dictyopteris* and *Spatoglossum* most generally isolated? Cohn and, at one time, Thuret were inclined to consider the sorus of *Dictyota* as the homologue of the Floridean cystocarp. Spite of many attempts, no one has observed any signs of a procarpium, Thuret and Bornet having traced the sorus in its earliest recognizable condition from superficial cells of the thallus.

* L. Guignard, "Développement et Constitution des Anthérozoïdes" (Revue Gén. de Bot. i. (1889), no. 4.

† L. Guignard, in Revue Gén. de Bot. i. (1889), no. 3.

‡ I must offer as an excuse for the incompleteness of my observations on this point that the grant from the Royal Society was made to enable me to carry out investigations on the *Florideæ*, and I did not feel justified in spending much time on the *Phæophyceæ*, but contented myself with preserving the material for subsequent examination.

The isolated position of the undivided spores in *Dictyopteris* and *Spatoglossum* is, too, a strong argument against a Floridean affinity. Reinke suggested, in 1878*, that fertilization may take place before the undivided spores have left the thallus, the male corpuscles being passively brought into contact with the oogonia, and exercising their fertilizing-power through the enveloping oogonium membrane, as in the *Bangiaceæ*. It is not at all difficult to find the undivided spores escaping as quite naked spherical non-motile bodies, without any signs of a preceding attachment of the male corpuscles. Further, Thuret found that it was only with considerable difficulty the escaped spores in *Dictyota* could be made to germinate, and that the seedlings died in the course of a few days. Thuret's observations thus tend to show that the undivided spores are not the products of fertilization; and that if oospheres, they are not parthenogenetic. There is everything to indicate that the undivided spores in the *Dictyotaceæ* are oospheres, that in *Dictyota* and several other genera there are oogonia in sori, that in *Dictyopteris* and *Spatoglossum* there are oogonia unilocular and isolated, and that fertilization, as yet not seen, takes place in the *Dictyotaceæ*, as in all *Phæophyceæ* in which it is known, *externally*,—*i. e.* after the oospheres have become quite free from the thallus producing them.

Briefly summarizing, it will be seen that:—

1. In their apical growth,
2. In the *parenchymatous* manner of formation of the thallus,
3. In the secondary thickening, as seen in the stalk of *Dictyopteris* and probably *Zonaria*,
4. In the brown pigment,
5. In the presence in the undoubted *Phæophyceæ*, the *Tilopteridæ*, of potential tetraspores very comparable to the tetraspores of the *Dictyotaceæ*,
6. In the parenchymatous structure of the antheridia and in the male corpuscles, to omit all mention of the possibility of cilia,
7. In the presence of isolated scattered oogonia in *Dictyopteris* and *Spatoglossum*,

the *Dictyotaceæ* possess characteristics which are not otherwise peculiar to the *Florideæ*, that, in fact, they are true *Melanophyceæ*.

I hope I shall not be considered presumptuous in going a step

* Reinke, in 'Nova Acta Leop.-Carol.' (1878) p. 48.

further and seeking to ascertain their position in the *Phæophyceæ*. In this connection I attach very great importance to the observations of Reinke on the *Tilopterideæ* *. The members of this group have a thallus which is *Sphacelaria*-like below, *Ectocarpus*-like above. They have large non-motile quadrinucleate spores (potential tetraspores) borne by wholly asexual plants (e.g. *Haplospora globosa*, Kjellm.), unilocular oogonia, non-motile oospheres like those of the *Dictyotaceæ*, external fertilization, plurilocular antheridia, antherozoids like those of the *Cutleriaceæ* and the *Fucaceæ*. The seedlings resulting from the germination of the asexual spores are, as Reinke states, very much like the corresponding seedlings of the *Dictyotaceæ* as described by him in 1878, and the description he gives of the formation of proliferations from the root-hairs in *Tilopteris globosa* would apply, almost word for word, to the case of *Dictyopteris polypodioides*. Except in the absence of apical growth, the *Tilopterideæ* form an easy transition to the *Dictyotaceæ*. Bornet † has this year described the species *Pylaiella fulvescens*, Thur., showing that its intercalary unilocular sporangia contain, each, a single large zoospore which is in size and all essential points, except its apparent power of ready germination, like the zoosphere of the *Cutleriaceæ*. This plant with these organs and its creeping thallus were known to Thuret and Bornet in 1870. Bornet has not yet been able to find antheridia. In the possession of these zoosphere-like bodies *Pylaiella fulvescens* agrees with *Pylaiella nana*, Kjellm., and apparently *Pylaiella littoralis*.

Thuret and Bornet, in 1876, described ‡ in *Ectocarpus Zebelii*, Kuetz., and *Ectocarpus secundus*, Crouan, two kinds of plurilocular sporangia. In the one kind they found ciliated bodies of small size, indistinguishable from the antherozoids of *Cutleria* or *Fucus*. In the other kind bodies like the zoospheres of *Cutleria*, like the zoospores of *Pylaiella fulvescens* are found, but whether they can germinate directly or need first fertilization is still a question of observation. The condition of the reproductive organs in *Ectocarpus pusillus*, *Ectocarpus siliculosus*, *Giraudia sphacelarioides*, and *Scytosiphon*, as ascertained by Goebel and Berthold, is well known from the English translation of Goebel's 'Outlines of Classification

* Reinke, in Bot. Zeit. t. ii. & iii. nos. 7–9 (1889).

† Bornet, "Note sur l'*Ectocarpus* (*Pylaiella*) *fulvescens*, Thuret," in Revue Gén. de Bot. i. (1889), no. 1, pl. i.

‡ Thuret and Bornet, 'Études Physiologiques,' p. 24.

and Special Morphology,' p. 67. The affinities of the *Dictyotaceæ* to these *Phæosporeæ* may be thus roughly represented:—

DICTYOTACEÆ.

TILOPTERIDEÆ.

Pylaiella fulvescens.
Pylaiella littoralis.

Ectocarpus secundus.
? *Ectocarpus Zebelii.*

Ectocarpus siliculosus.

Ectocarpus pusillus.

The material on which my investigations have been made was obtained by dredging, mainly off the Mewstone in Plymouth Sound.

I take this opportunity of acknowledging my indebtedness to Mr. G. C. Bourne, late Director of the Marine Biological Laboratory, Plymouth, for having placed at my service the steamboat and other accessories for collecting-purposes. Having regard to the requirements of the zoologists at the Laboratory, I could scarcely have enjoyed greater facilities had they been entirely under my own control.

EXPLANATION OF PLATE XIII.

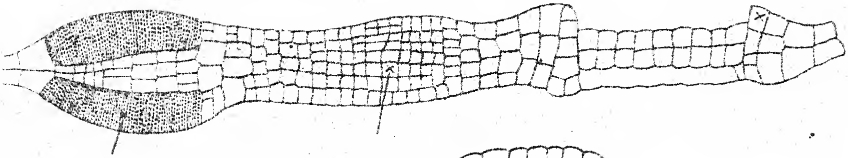
Fig. 1. Transverse section of thallus of male plant showing midrib and antheridia. × 120. *m*, midrib; *a*, ripe antheridium; *a'*, dehisced antheridia; *i*, involucre.

2. Transverse section of stalk showing secondary cortex. × 120. *m*, midrib of fig. 1; *c*, cambium cell; *sc.c.*, secondary cortex; *s*, scar left by disappearance of lamina of thallus.

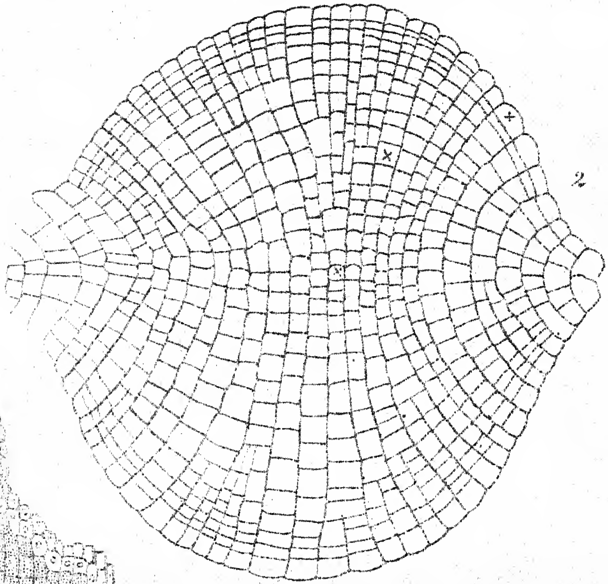
3. Longitudinal section of stalk. $\alpha \times 120$; $\beta \times 480$.

4. A portion of male plant showing antheridia in position. × 3. *h*, tuft of hairs.

5. A portion of thallus showing an antheridium in surface-view. × 120.



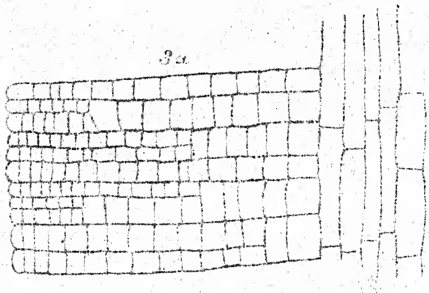
1

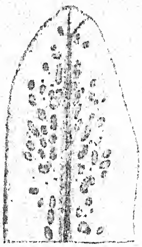


2

3

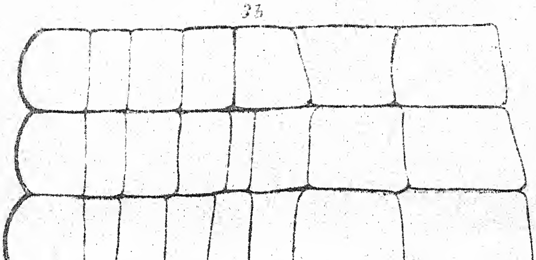
3a





4

3b



T. Johnson del.

J. N. Fitch lith. & imp.

STRUCTURE OF DICTYOPTERIS.

Further Contributions to the Flora of Patagonia.

By the late JOHN BALL, F.R.S., M.R.I.A., F.L.S., &c.

[Read 6th February, 1890.]

IN the autumn of 1888 Mr. Williams Andrews, a gentleman who has enjoyed exceptional opportunities for exploring the interior of Patagonia, presented to the Herbarium of the Royal Gardens at Kew a small collection of plants made by him in the course of his travels in that country. The specimens were, as far as possible, identified by Professor Oliver, who was good enough to invite me to examine the collection before the specimens were intercalated in the Herbarium.

As the collection, though small, is of considerable interest as an addition to our knowledge of a little-known region, I have thought it desirable to present a short account of it to the Linnean Society. I was tempted to make use of the same occasion to give a complete enumeration of the plants hitherto known to inhabit Patagonia; but, although there is no great difficulty in putting together the rather scanty materials to be found in published works, I find reason to believe that a full examination of the collections in the herbaria at Kew and at the British Museum would add a good many species to the list, and this task I am forced to postpone to a future occasion.

As whatever interest may attach to the present short paper is mainly that of a contribution to botanical geography, it may be well to premise a few remarks on the topography of the region now in question.

Leaving out of account the narrow fringe of coast lying on the west side of the continent between the southern extremity of the Andes and the waters of the Pacific, which, with the parallel range of mountainous islands, is sometimes styled Western Patagonia, the name is properly limited to the southern part of the American continent lying east of the Andes, which is drained by streams running into the Atlantic Ocean. The greater part of this region is a broken plateau, raised from the sea during the latest geological period, and nowhere exceeding a few hundred feet above sea-level. The streams that flow to the Atlantic throughout a distance of ten degrees of latitude are for the most part inconsiderable, the most important being the

a plant is found at a great distance from what appears to be its native home.

It has appeared to me interesting to see how far the collections received from Patagonia serve to show that the range of the Andes has served as a barrier between the floras of the eastern and western sides of temperate South America. Leaving out of account species that have a wide range throughout the entire continent, and those which must be considered doubtful, I find in the present small collection 30 species that are confined to the eastern side of the Andes and 40 that extend to the western as well as the eastern side of the great range.

Mr. W. Andrews is not a botanist, and does not use technical terms, but he is evidently a good observer, and I have thought it desirable to give in the following list, within inverted commas, the notes which he sent with most of his specimens, and which are preserved along with them in the Kew Herbarium.

List of Plants collected in Patagonia by Mr. Williams Andrews.

RANUNCULACEÆ.

13*. CLEMATIS BONARIENSIS, *DC.* "Common in the valley of the Rio Negro, especially on the Balcheta and Bajalta Streams." —*W. Andrews.* This species is widely spread on the E. side of South America. It has been collected throughout Argentaria from Buenos Aires to the extreme northern provinces (Jujuy and Oran), and it now appears that it extends southward to Patagonia. This species has been wrongly attributed to Jussieu, as it was first described and published by DeCandolle in the 'Regni Vegetabilis Systema Naturale,' i. p. 145. Closely allied to this is *Clematis Hilarii*, Spreng. Syst. Veg. Index, 177, = *C. triloba*, St.-Hil. non Heyne, which is also the same as *C. montevidensis*, Spreng. Syst. ii. 667. This has an equally wide geographical range, from South Brazil to Uruguay and Argentaria, and there is a specimen in the Kew Herbarium from Patagonia collected by Tweedie.

* For convenience of reference I have affixed the numbers given with his specimens by Mr. Williams Andrews which are marked in red pencil on the labels in Kew Herbarium. In a few cases the same number is affixed to different species, and in several others specimens of the same species have been sent with different numbers.

In his elaborate monograph of the genus *Clematis* (Verhandlungen des Botanischen Vereins der Provinz Brandenburg, xxvi.), Otto Kuntze has united, under the specific name *C. dioica*, L., all the species of the *Vitalba* section hitherto described from North and South America. Not having studied the genus with sufficient care, nor had access to the large mass of materials which have been examined by the learned author, I do not at present attempt to criticize his work, but with regard to several forms with which I am acquainted I am not at present prepared to assent to his conclusions, nor to the principles which he seeks to apply in systematic botany. To take a familiar instance, I do not think that it conduces to our knowledge of the vegetable kingdom, which is the proper object of systematic botany, to unite under the same specific name plants which, inhabiting nearly the same geographical area, maintain themselves so unmistakably distinct as to have been so recognized by all botanists from the time of Linnæus, as *Clematis recta*, L., and *C. Flammula*, L. With regard, however, to the species of temperate South America, I am disposed to agree in the propriety of uniting under one specific name *C. bonariensis*, DC., and *C. Hilarii*, Spreng. Both are very variable plants, and the only important difference is that *C. bonariensis* is said to be polygamous, while *C. Hilarii* is diœcious. O. Kuntze, as I believe with reason, regards this difference as variable amongst the American forms which he unites under *C. dioica*, and DeCandolle's remarks (*loc. cit.*) leave the question doubtful. If we unite under one name the forms of temperate South America, the proper designation is *C. bonariensis*, DC. Under this, either as synonyms or as varieties, should be ranged *C. campestris*, St.-Hil., *C. mendocina*, Phil., and probably also some Brazilian forms.

It is remarkable that no species of *Clematis* has been found on the western side of South America south of Peru.

BERBERIDEÆ.

50. BERBERIS HETEROPHYLLA, *Juss.* "Shrub 5–10 ft. high flowers white, berries purple: the Indians eat them in quantity and make a drink from them. Common throughout Patagonia." —*W. Andrews*. This species extends northward from the Straits of Magellan, and there are specimens in the Kew Herbarium

from Port Sta. Elena, Cape Fairweather, and Port Desire, but it has not been found on the west side of the Andes.

CRUCIFERÆ.

5. VESICARIA MENDOCINA, *Phil. in Linnæa*, xxxiii. 12, = V. andicola, *Gill. MSS. in Herb. Kew.* = V. montevidensis, *Eichl. in Flor. Bras.* xiii. 302, tab. lxvii. = V. arctica, *Hook. Bot. Misc.* iii. 138, *et Barn. in C. Gay, Fl. Chil.* i. 161, *non Richardson, Bot. App. Franklin's Journey*, 15, *et Hook. Fl. Bor.-Amer.* t. i. "On the edge of table-land, sandy or stony ground. Native name *Aleli*." —*W. Andrews*. There has been much confusion as to the name of this plant and as to its geographical distribution. It was first collected by Gillies on the lower slopes of the Andes near Mendoza, and sent to Sir William Hooker with the manuscript name *V. andicola*. It was, however, supposed to be identical with the *Vesicaria arctica* of Richardson, and in the Hookerian herbarium, now incorporated with the general collection at Kew, was laid on the same sheet with the North-American plant. Other specimens from the same neighbourhood were sent by Cruckshanks, which are incorrectly marked Chili on the sheet in Kew Herb. (*vide* Hooker, *loc. cit.*). The same plant was collected by Tweedie in North Patagonia, aad by Sello in Uruguay. Eichler described Sello's plant under the name *V. montevidensis* in the part of the 'Flora Brasiliensis' which appeared in December 1865; and in his 'Symbolæ ad Floram Argentinam,' p. 16, Grisebach, recognizing the identity of Eichler's plant with that of Gillies, adopted the name *V. montevidensis* and rejected the name *V. andicola*, because the plant appears to grow only on the lower slopes of the Andes. In describing the plants collected by M. Claraz (Journ. Linn. Soc. xxi. 212) I called the plant *V. andicola*, Gill., because the objection stated by Grisebach is certainly invalid. But I did not advert to the fact that *V. andicola* is merely a manuscript name never published, and that apart from a single sheet in Kew Herbarium, there is no way of identifying it. Further than this, I was not then aware that early in 1864 Philippi, who had received specimens from the neighbourhood of Mendoza, published a correct description of it in the 'Linnæa' under the name *V. mendocina*, which name, under the law of priority of publication, it must now retain.

The plant has a wide range on the east side of the Andes, but

is probably most common in Patagonia, as it is included in all the collections from that region, and has received a native Indian name. It is not properly included in the floras of Chili or Brazil.

BIXACEÆ.

107. AZARA MICROPHYLLA, *Hook. f. Fl. Antarct.* 244? Uncertain because the specimen has neither flower nor fruit, but closely resembling the foliage of that species, which is known only from Southern Chili and the island of Chiloe. A further reason for doubt is that so few species are common to the opposite coasts of the South-American continent.

PORTULACEÆ.

4. PORTULACA GRANDIFLORA, *Hook. Bot. Mag.* tab. 2885. "Flowers in June and February; abundant among the sandhills near the coast of North Patagonia; flowers a brilliant magenta." —*W. Andrews.* This appears not to be a common species, but has been collected at various spots in the territory extending from Mendoza to North Patagonia. Specimens collected by Balansa in Paraguay which I have seen in the Kew Herbarium apparently belong to an undescribed species allied to *P. grandiflora.* The flowers are said to be of a purple colour.

19. PORTULACA OLERACEA, *L.* "Much esteemed by the natives as a cleanser of the blood, is eaten raw as a salad or boiled and dressed as spinach. Local name *Verdu larga*; found chiefly near rivers, and also near the coast."—*W. Andrews.* This is one of the most widely spread of cosmopolitan weeds, being found in almost all temperate and tropical parts of the earth, not only in continental regions and Australia, but also in Madagascar, the islands of the Indian Ocean, in most of the Pacific islands, and even in many remote oceanic islands of volcanic origin. It may be conjectured that the agency of birds as well as that of man has been requisite to achieve the result.

Another plant of the same natural order, *Grahamia bracteata,* Gill., was collected in Patagonia by Tweedie, and, more recently, in the valley of the Rio Negro by Niederlein. It is common in some parts of Argentaria, but is apparently confined to the east side of the Andes.

MALVACEÆ.

102. SIDA SULPHUREA, *A. Gray, Pl. Fendl.* 23,=Malva sulphurea, *Gill. in Hook. Bot. Misc.* iii. 149,=Malvastrum sulphureum, *Griseb. Symb.* 43. Though not, as I believe, anywhere common, this species has a wide range on the east and west sides of the continent.

33. SPHÆRALCEA ——? "Grows on the plains, flowers bright purple or magenta."—*W. Andrews.*

64. SPHÆRALCEA ——? "From the plains; flowers bright crimson."—*W. Andrews.* I have no doubt that this and the last are forms of the same species, but I am not able with certainty to refer them to any of those described. The very numerous *Malvaceæ* of temperate South America, especially those belonging to the genera *Malva, Sphæralcea, Malvastrum,* and *Cristaria,* urgently require careful examination by a botanist who can study the living forms; from incomplete herbarium specimens it is often difficult to fix even the generic position. These specimens are certainly nearly allied to *Sphæralcea bonariensis,* Griseb. Pl. Lor. 45,=*Malva bonariensis,* Cav. I find it impossible to fix the limits between that species and *S. cisplatina,* St.-Hil. Pl. Us. t. 52, and *S. obtusiloba,* G. Don, Gen. Syst. i. 465,=*Malva obtusiloba,* Hook. in Bot. Mag. 2787. These are all very variable plants, especially the last, from which I think it is impossible to separate *S. coquimbana,* Phil., *S. collina,* Phil., and *S. flexuosa,* Gill., MSS. in Herb. Kew. The specimens sent by Mr. Andrews have the lobes of the leaf more sharply cut than in any of the forms above enumerated, but I should conjecturally refer them all to a single very variable species which extends to both sides of the S. American continent, and which may best bear the name SPHÆRALCEA BONARIENSIS.

22. SPHÆRALCEA ——? "Blossom of a brilliant scarlet or deep crimson, like a minute poppy; found in clay soil on low plains, especially near burrows of the *Vizcacha.*"—*W. Andrews.* This is doubtless allied to *S. bonariensis,* but cannot, I think, be referred to that species. The stem, which is woody at the base, is divided into numerous feeble trailing branches, the leaves are small pinnato-lobate with narrow segments, hoary on both faces. This is possibly an abnormal form growing in manured soil near the burrows; the foliage much resembles that of a small specimen

collected by Captain King at Port Sta. Elena, to which the MSS. name *Malva crispa*, Hook. fil., is appended in Kew Herbarium. That plant, however, appears to be a *Malvastrum*, and the materials available for the study of this group are at present too scanty. In the botanical chapter of the 'Informe Oficial de la Expedicion al Rio Negro,' published in 1881, Niederlein has described two plants from the valley of the Rio Negro, one of which he has named *Malva patagonica*, and the other is said be nearly allied to, if not the same as, *Malva brevipes*, Phil.

Tiliaceæ.

114. Aristotelia Maqui, *L'Hérit.* This plant is common in Central and Southern Chili, having its northern limit (*vide C. Gay*, 'Flora Chilena,' i. p. 337) at the river Illapel, about S. lat. 31° 30′. Excepting this specimen, I have seen none from the eastern side of the continent save those collected by Tweedie in Uruguay. The genus belongs exclusively to the southern hemisphere, the other known five or six species being natives of New Zealand, Australia, or Tasmania.

Zygophylleæ.

27. Larrea divaricata, *Cav.* "Shrub attaining a height of 12 or 15 feet, though generally less; always found on the high table-lands; soil, sand and clay with pebbles; disappears towards the west as soon as the mountain-ranges of Central Patagonia commence. It is of a highly resinous nature, and burns with a bright crackling flame; but the smoke possesses a strong acrid taste and odour, as does the foliage when bruised. The flowers, which appear in great profusion, are small golden stars, which in their turn give place to small round seed-globes covered with a white cottony fur. The wood is very hard, and in many respects like box. This is one of the handsomest shrubs of the uplands, presenting at one time a brilliant map of yellow, at another (when in seed) of white, whilst the elegance of its growth always attracts attention. Local name *Jarilla*, but also called *Cordoba compass*, as its growth is said invariably to be from south to north."—*W. Andrews*. This species extends from Central Patagonia northward to many stations in Argentaria as far as Catamarca. Although included in the 'Flora Chilena,' I do not

believe that it has been found on the west side of the Andes. Specimens collected by Tweedie, and labelled South Brazil, are almost certainly from Uruguay.

27. Larrea cuneifolia, *Cav.* This has been sent by Mr. Andrews with the same number as the last species. It has nearly the same geographical range, but appears to be less common.

52. Larrea nitida, *Cav.* "Shrub growing on high dry ground, very resinous, burns with a bright flame, dense smoke, and acrid odour—small yellow blossoms which grow on the leaf." —*W. Andrews.* Elsewhere Mr. Andrews says that this species is not found in the valley of the Rio Negro, but on the outer slopes of the Andes above the junction of the rivers Limay and Nenquen. It extends northward to the outer slopes of the Andes both on the eastern and western sides to about S. lat. 30°.

The secondary branches often bear four or five pairs of opposite leaves very regularly disposed, and Mr. Andrews apparently regarded them as forming a pinnate leaf. The flowers and fruit are borne on very short thick pedicels.

Geraniaceæ.

94. Geranium patagonicum, *Hook. f. Fl. Antarct.* 252. This appears to agree closely with authentic specimens from Southern Patagonia and Fuegia. Those from the island of Juan Fernandez, from Monte Video, and from Mendoza, which have been doubtfully referred to this species, may perhaps be better ranked under *G. intermedium*, Bertero, unless they should all be regarded as forms of the same species.

108. Oxalis valdiviensis, *C. Gay?* "Yellow blossom, shamrock-like leaves, tuberous root, and sharp acid flavour when chewed."—*W. Andrews.* Except by somewhat larger flower this does not seem different from the Chilian species.

Leguminosæ.

32 and 96. Glycyrrhiza astragalina, *Gill.* "Plant of a dark green brilliant foliage; flowers of a pale purple; always found on low ground and in the vicinity of water. The leaves exude a thick viscid humour when pressed, and communicate a

sweet flavour. The root yields a dark brown dye. The height varies from 6 inches to 3 feet. Local name *Urasu*, or liquorice plant."—*W. Andrews*. This plant seems to extend through a large part of temperate South America. It is nowhere common, but is less rare on the eastern than on the western side of the Andes.

6. Adesmia muricata, *DC.*? Very imperfect fragments without fruit.

24 and 105. Vicia graminea, *Sm. in Rees's Cyclop.* xxxvii. "A small Vetch with blossoms of a deep brilliant blue with white at the throat. Found in valleys, soil clay and moist. Very widely distributed and abundant in mountain-ranges of Central Patagonia."—*W. Andrews*. The vetches of South America are very puzzling to the botanist. A considerable number of closely allied forms extend through the continent from the equator to the Straits of Magellan, if not also to Central America and Mexico. The typical form of *V. graminea* is, I believe, confined to the east side of the Andean chain, but closely allied varieties or subspecies are found in Chili.

103. Lathyrus tomentosus, *Lam.* "Large blue blossom, amongst sand-hills near coast."—*W. Andrews*. This appears to be a characteristic species of the east side of the continent, extending from Port Desire (Puerto Deseado) in Patagonia northward to Uruguay. Specimens labelled "Brasilia," collected by Sellow, were probably collected in Uruguay.

14. Lathyrus pubescens, *Hook. & Arn., Bot. Beech. Voy.* p. 21. "White blossom, found along the banks of streams climbing among shrubs; especially abundant in the vicinity of Conesa on the Rio Negro."—*W. Andrews*. This species has a wide range both on the eastern and western sides of the continent, extending from the Chonos Archipelago northward to Bolivia and Peru, and from Patagonia to Catamarca.

30. Cæsalpinia Gilliesii, *Benth.* "Shrub attains a height of 5 feet or a little more. Flowers light yellow, from the centre of which falls a group of bright scarlet stamens. The seed is contained in a pod similar to that of a pear, but is flat. Found on table-lands in sandy soil."—*W. Andrews*. This very ornamental

plant appears to be not uncommon in some parts of Argentaria, and elsewhere to occur sparingly at rather wide intervals from Central Patagonia to Uruguay, and on the west coast extends somewhat north of the tropic of Capricorn.

25. Hoffmannseggia falcaria, *Cav.* "Small plant; height 4 to 6 inches, grows on clay soil in valleys of streams, though often at a considerable distance from water; flowers a dark orange, mottled with deep brown spots."—*W. Andrews.* This is a small form of a species which extends to the northern Argentine States and also to the Chilian coast, generally growing to about 1 foot in height.

98. Hoffmannseggia trifoliata, *Cav.* "Plant with small dark yellow blossoms, mottled in throat with spots of very dark purple growing in a spike; generally in neighbourhood of sea-coast or river."—*W. Andrews.* This species, rare in herbaria, is one of the few that appear to be peculiar to Patagonia. It was originally described by Cavanilles from specimens collected at Puerto Deseado.

29. Cassia aphylla, *Cav.* "Shrub leafless and low growing, height about 10 inches; with yellow (dark gold) bell-like blossoms; always found on high table-lands in dry sandy soil."—*W. Andrews.* This is apparently confined to the east side of the continent, ranging from Northern (or Central ?) Patagonia to the Northern States of the Argentine Confederation.

43. Prosopis strombulifera, *Benth. in Hook. Journ. Bot.* iv. p. 352. "Dwarf shrub; height varying from 4 to 10 inches; root a very long straight tap descending perpendicularly. It is found throughout the plains of the Rio Negro valley, generally in clay ground. Blossom a reddish yellow; fruit-pods of a bright yellow in closely twisted spirals, four or five growing together on a single stem. A decoction of these has a sweet, bitterish, and aromatic flavour, and is used both by natives and Indians as a sovereign specific for dysentery, diarrhœa, &c. Local name, *Saco trapo.*"—*W. Andrews.* I am inclined to believe that the range of this species is confined to the eastern side of the Southern Andes from Catamarca to Northern Patagonia, but not approaching the Atlantic coast. There is a specimen sent by Mr. Reed from Camarrones in Chili in the Kew Herbarium;

but in C. Gay's 'Flora Chilena,' Clos remarks that this species, which he wrongly supposes a native of Peru, is cultivated in gardens in Chili, probably for the sake of its medicinal properties. It is called in Chili *Retorton*. In the same work it is described as growing (in gardens ?) to a height of from 5 to 8 feet, very much exceeding the stature of the wild plant.

The singular group of species which Bentham distinguished as a section of the genus *Prosopis* by the name *Strombocarpa*, and to which Asa Gray was disposed to give generic rank, seems to be limited to the eastern side of Extratropical South America (Argentaria and North Patagonia), and to the dry region of North America extending from Western Texas to Arizona and Northern Mexico. There are, indeed, two described species—*P. reptans*, Benth. in Hook. Journ. Bot. iv. p. 352, known only from the central provinces of Argentaria; and *P. cinerascens*, A. Gray, Pl. Wright. i. p. 61, from North Mexico and the adjoining region, which can scarcely be separated. Bentham in Trans. Linn. Soc. xxx. p. 381, says of *P. cinerascens*, "Fructiculus *P. reptanti* simillimus, nec distinguendus nisi pube evidentiore præsertim in pedunculis, et interdum in floribus ipsis, et foliolis paullo majoribus et 1½ lineam longis." Were it not for the wide difference in the habitat, Mr. Bentham would not have separated these plants, especially as in some specimens of each there is no apparent difference in the length of the leaflets. The legumes in Mr. Andrews's specimens are somewhat larger and thicker than in the other specimens of *P. strombilifera* which I have seen, but I should not distinguish it even as a variety.

SAXIFRAGEÆ.

66. ESCALLONIA —— ? "Shrub abundant on eastern slopes of the Andes."—*W. Andrews.* I have had no opportunity of observing the species of this genus on the eastern side of South America; but I was much struck by the extreme variability of the forms encountered on the lower slopes of the Chilian Andes. It seemed to me that it would be very difficult, even when studied in the living state, to assign good diagnostic characters by which to distinguish many of the species. I have ventured elsewhere to express the belief that this is one instance, of which several will occur to the student of the European Flora, in which the processes have not been completed by which, amongst a large

ing and nutritious. They are always found on high table-land; soil generally sandy and stony."—*W. Andrews*. The specimen seems to agree with one named by Philippi, and the species apparently inhabits both sides of the Andean chain.

Calycereæ.

7 and 38. Boopis crassifolia, *A. Gray in Proc. Amer. Acad.* v. 321; *Hook. Ic. Pl.* t. 1752, = Acicarpha crassifolia, *Miers*. "Plant with bright stiff leaves and a large yellow blossom, somewhat resembling *Helichrysum*, in height from 1 to 2 feet; always met with in sandy soil and most common amongst *medanos*, especially those of the sea-coast, and occasionally found on the higher table-lands. One of the most common plants of Patagonia, extending south to the Straits of Magellan."—*W. Andrews*.

In the remarks which Professor Oliver has added to the description in the 'Icones' above cited he points out that this species should be referred to *Calycera* rather than to *Boopis*, if the latter be maintained as a distinct genus. But he adds the expression of a doubt whether this should not be included in the original genus *Calycera*. Amongst the species now known there are many intermediate in structure between the typical *Boopis anthemoides* and the true *Calycera*, as defined in Bentham and Hooker's 'Genera Plantarum.' There is nothing in the habit or the geographical distribution of the species referred to one or the other genus that tends to show that they should be separated.

Compositæ.

41 and 90. Steira satureifolia, *Sch.-Bip.*, var. angustifolia, *Baker*. "Plant resembling candytuft; height about 8 or 10 inches; grows in sandy soil near the sea-coast, and generally in plains of Rio Negro valley; blossoms a mawkish pink."—*W. Andrews*. This very variable species has a wide range on the eastern side of the continent, from Brazil to Northern Patagonia, but has not been found on the western side of the Cordillera.

93. Grindelia pulchella, *Dun. Mém. Mus. Par.* v. 51, tab. 6, = G. diffusa, *Gill.* ex *Hook. et Arn. Comp. Bot. Mag.* ii. 45. "Plant with yellow flower, grows in sandy districts."—*W. Andrews*. This species appears to be confined to the east side of the Andes.

92. Grindelia speciosa, *Gill.* ex *Hook. et Arn. Comp. Bot. Mag.* ii. 45, var.? "Plant of large bushy habit, grows luxuriantly amongst sand-hills near the coast; large yellow flower."—*W. Andrews.* I am by no means sure that this belongs to the species found by Dr. Gillies in the interior of the continent near Mendoza. The scales of the involucre are far less unequal, the exterior being broader and the interior less broad than in the original plant. The leaves also appear to be different in texture and the venation much more conspicuous.

G. speciosa has been found at many places on the E. side of the Andes and has not been found by the Chilian botanists: but one specimen from Gillies is labelled "Andes of Chili."

75. Haplopappus coronopifolius, *DC. Prod.* v. 347,=Diplopappus coronopifolius, *Less.* This agrees perfectly with Chilian specimens. It appears to be common in the provinces of Valdivia and Concepcion; but, excepting this, I have seen no specimens from the eastern side of S. America.

9, 99, and 116. Leucopsis sericea, *Baker in Mart. Fl. Bras.* vi. III. 7,=Aster sericeus, *Less.*,=Aplopappus sericeus, *Hook. et Arn. Comp. Bot. Mag.* ii. 47. "Plant with grey foliage, yellow blossom, developing subsequently into white down; common throughout plains, found also on high plains, but very stunted in growth."—*W. Andrews.* This is one of the few species that seem to have an equally wide range on both sides of the Andes in temperate South America. The specimens marked 99 are nearly the same as Baker's variety *eriophora*, which is the same as *Noticastrum eriophorum*, Remy in C. Gay, Fl. Chil. iv. 20.

83. Baccharis magellanica, *Pers.* "Low-growing shrub, growing amongst rocks and in moist parts of high ground."—*W. Andrews.* Hitherto I believe that this species is known only from the coasts of the Straits of Magellan.

42. Baccharis artemisioides, *Hook. & Arn.* "Shrubby plant, silvery foliage, height about 1 foot; blossoms greenish grey, afterwards turning to white down. Found in sandy soil, more especially by the immediate edge of the plateaux; very abundant between Punta Rubra and Patagones; grows by the rivers Negro and Chubat."—*W. Andrews.* With reference to the

above statement as to the colour of the pappus, I note that in most specimens that I have seen the pappus is distinctly rufous, especially in one collected by Tweedie at Bahia Blanca; in those collected by Mr. Williams, and in one from Monte Video, the colour of the dry pappus would be described as dirty white. The range of this species is considerable, but apparently confined to the eastern side of the continent. It extends from about the 44th to the 30th degree of S. latitude; but, although included in the 'Flora Brasiliensis,' has not, I believe, been found in Brazil.

48. BACCHARIS GLUTINOSA, *Pers.* "Shrub; height from 4 to 6 feet; blossom white. Very general along the course of the Rio Negro; to the south is always met with in sheltered valleys and generally in the neighbourhood of water."—*W. Andrews.* The distribution of this very variable species is very singular. On the west side of the continent it extends from the neighbourhood of Lima to Southern Chili through some 27 degrees of latitude. On the eastern side, where it is less common, it extends from Northern Patagonia to Uruguay and the Central Argentine provinces, but not to Brazil. Specimens that I have seen from Paraguay and Southern Brazil appear to belong to *B. serrulata*, Pers., which I believe to be a distinct species with longer, broader, and more numerous involucral bracts.

37. BACCHARIS NOTOSERGILLA, *Griseb.* "Shrubby plant, height from 1 to 2½ feet; small yellowish-white blossoms; has a very strong aromatic scent; found in sand and clay ground, always in valleys and low-lying parts; local name *Escobilla.* Is employed by the natives to make brushes similar to our besoms. Very widely distributed; in places, as between Roca and Chinchinal, forms almost the sole vegetation, and reaches right from the sea-coast to the foot of the Cordillera and southward to the Straits of Magellan."—*W. Andrews.* This species has hitherto been known only from Montevideo and the Central Argentine provinces. It evidently has a much wider range, but until specimens have been received there must be some doubt as to its extension to the Magellanic region. Like the two preceding species, it is included in the 'Flora Brasiliensis,' although not, so far as we know, a native of Brazil.

6. BACCHARIS GILLIESII, *A. Gray in Proc. Amer. Acad.* v. 173, var.? "Small shrubby plant; dark green foliage; grows in

sandy and salt ground; common in the lower valleys of the Chubat and on the sea-coast."—*W. Andrews.* This specimen, named as above by Professor Oliver, seems to me very doubtful. It appears to be very nearly allied to *B. valdiviana*, Phil. in Linnæa, xxviii. 138.

62. GNAPHALIUM SPICATUM, *Lam.* "Silvery-leaved plant growing in gravel."—*W. Andrews.* This species extends from Mexico through the west side of tropical America to the South-temperate zone, at least as far as Northern Patagonia. If I am right in believing that *G. americanum*, L., and *G. purpureum*, L., are forms of the same species, they should be united under the name *G. americanum*, and will be found to extend over an area of fully 80 degrees of latitude.

20. GAILLARDIA SCABIOSOIDES, *Benth. et Hook. f. Gen. Pl.* ii. 414=Cercostylos scabiosoides, *Arn. in DC. Prod.* "Plant bushy, about 15 inches high, grows in dense masses on low clay plains. The blossoms, which are without exterior petals, possess a strong odour resembling that of ripe apricots. These fresh, or powdered into a kind of snuff, are much used by the natives as a remedy for headache. Foliage of a dark green, somewhat white on the lower surface."—*W. Andrews.*

In the 'Symbolæ ad Floram Argentinam' Grisebach correctly quotes the 'Genera Plantarum' for the name of this species, as the species is there named and distinctly referred to *Gaillardia.* I have seen no specimens of the Brazilian plant with undivided leaves (*Guntheria megapotamica*, Spreng.=*Cercostylos brasiliensis* of Lessing); but I have no doubt that Mr. Baker has been well advised in uniting the two as forms of a single species. On further consideration I cannot, however, concur with him in reviving Sprengel's specific name as that of the type of the collective species. The Brazilian form is rare, at least in European herbaria, while *G. scabiosoides* appears to have a considerable range on the western side of temperate South America and to be comparatively common. (See Journ. Linn. Soc. Bot. xxi. 223.)

63. SENECIO MISER, *Hook. f.* "Small creeping plant, grows amongst rocks and on edges of springs, also on plains in neighbourhood of Port Desire; has a pleasant and aromatic odour."—

W. Andrews. I believe that this species is confined to South Patagonia and the coasts of the Magellan Straits.

A specimen in the Kew Herbarium is labelled "Maldonado, Tweedie;" but it is allowable to suspect that the label has been misplaced.

69. SENECIO SUBULATUS, *D. Don*, ex *Hook. et Arn. Journ. Bot.* iii. 320, var.? "Large bushy shrub, yellow blossoms, very luxuriant, found in sand-hills on sea-coast."—*W. Andrews*. This specimen is in most respects intermediate between *S. subulatus* and *S. linariæfolius*, Poepp. *ex* DC. Prod. The typical *S. subulatus* was first found by Dr. Gillies in the province of Mendoza, and it appears to be common in the pampas of the interior provinces. The same plant was distributed under the name *Senecio mendocinus*, Phil., but not published by Philippi. *S. linariæfolius* is said to be common in the Chilian Cordillera. In the place above referred to, Hooker and Arnott have united to *S. subulatus* a plant of which poor specimens were collected by Tweedie near Bahia Blanca. The specimens sent by Mr. Andrews are from a much larger and more vigorous plant, have larger heads and rather broader involucral scales, but must, I think, be united with *S. subulatus*, unless both be included as forms of *Senecio linariæfolius*, which is the older name.

110. SENECIO RANCONENSIS, *Sch.-Bip. ad calc. Lechler Berberid.*, sine descriptione. "Plant with yellow flowers, straggling growth, height about 2 feet; grows under trees in thick woods on eastern slope of Andes."—*W. Andrews*. This agrees very well with Lechler's specimens from the Andes of Ranco, so that the species seems to inhabit the opposite slopes of the same portion of the great range. In his 'Catalogue of the Chilian Flora' Prof. Friedrich Philippi has amended the specific name to the more correct form *S. rancoensis*.

31. SENECIO HUALTATA, *Bertero*. "Plant growing with a large upright stalk; height 4 or 5 feet; leaves large, green and fleshy, the bigger leaves being at the lower part of the stem; flower-stalks shoot out from the upper part, bearing groups of white blossoms with a yellow eye, in appearance similar to but larger than the common horse-daisy; always found in low moist ground and around the edges of lakes."—*W. Andrews*. This conspicuous

species extends to both sides of temperate South America, but is more common on the Pacific slope.

84. Mutisia ilicifolia, *Cav. Ic.* v. 63, tab. 493. "Creeper; large bright orange blossom with dark centre. Slopes of the Andes and pre-Cordillerine districts."—*W. Andrews.*

85. Apparently the same plant; a single head. "Pink and carmine blossoms, also occasionally white."—*W. Andrews.*

This is not different from *M. truncata*, D. Don, and some forms are not easily distinguished from *M. spinosa*, DC. It is singular that this species is usually quoted "*M. ilicifolia*, Hook." Sir W. Hooker published a description of the plant in the 'Botanical Miscellany,' and in so doing referred to the description and figure previously given by Cavanilles. This species extends to both slopes of the Andes.

49. Hyalis argentea, *D. Don*, ex *Hook. et Arn. Comp. Bot. Mag.* i. 108. "Bushy plant, very general in all northern parts of Patagonia; grows in sand, especially amongst the *medanos* (sand-hills) near the coast. Foliage silvery white, flowers pink. Local name *Majai*: height about 2 feet."—*W. Andrews.* This ornamental species seems to be rather common in North Patagonia and extends thence to the Province of Mendoza; but it is very doubtful whether it has been found wild in Chili.

36. Chuquiraga erinacea, *D. Don*? "Shrub: prickly foliage, bright yellow blossoms in great abundance: very widely distributed, being found in all classes of soil, as well on high table-lands as in valleys, on sea-coast and in the interior. Branches of this boiled yield a yellow bitter fluid which the Indians take as a febrifuge. In Chubat the settlers have used it instead of hops in making a sort of beer."—*W. Andrews.*

I do not feel sure as to the identity of this species, nor do I unreservedly accept the statement that the same species is found everywhere in Patagonia. There are numerous nearly allied forms of ulicine Chuquiragas which seem to require careful study by a botanist possessing ample materials.

17. Stifftia chrysantha, *Mik.* "Blossoms of bush found in a sheltered valley near Lake Lajara in the Andes. Height about 4 feet."—*W. Andrews.* This is the most interesting object in the collection made by Mr. Andrews. This very fine species has

hitherto been found in Brazil, chiefly on the Corcavado and other eminences near Rio de Janeiro, and in the Province of San Paulo. The new habitat must be at least 1600 miles distant.

34. Brachyclados lycioides, *Gill.* ex *D. Don in Phil. Mag.* March 1832; *Hook. et Arn. Comp. Bot. Mag.* i. 106. "Shrub, height from 2 to 4 feet; hard dark green foliage; blossom of a deep gold-colour. Found chiefly on high table-lands on clay or stony soil, occasionally in valleys. Common on the Senger, Chubat, Deseado and Rio Negro."—*W. Andrews.* This species was originally found by Gillies towards the base of the Andes of Mendoza, and was soon after collected by Tweedie in North Patagonia. It is enumerated in the 'Flora Chilena,' iii. 312, and is said to grow in the Cordillera of the province of Santiago. I have seen no Chilian specimens, unless a single specimen in the Kew Herbarium, labelled "Bridges, Concepcion," belongs to the same species. This has the stem and branches erect, not spreading, nearly quite glabrous; the involucral scales nearly glabrous and the medial nerve much less prominent; and finally the achenes much larger. In the Patagonian plant the oblong achenes have five obtuse rounded ribs; in the Concepcion plant the fruit is not quite mature, but the achenes appear to have much more angular ribs. In this plant the branches bearing the flowering heads are often beset with projecting knobs which are abortive branches, and frequently bear a single minute leaf about an eighth of an inch in length. This is especially noticeable on the specimen from Concepcion above mentioned.

70 and 88. Trichocline incana, *Cass.* "Plant of small and compact growth, with yellow flowers. Generally found on open plains and in sandy soil; sometimes on clay."—*W. Andrews.* This species has a wide range in eastern South America, extending to the Peruvian Andes. It has not been found in Chili, and it is very doubtful whether any species of this genus extends to the western slope of the Andes. (See 'Flora Chilena,' iii. 288.)

106. Leuceria runcinata, *Gill.* ex *D. Don, in Phil. Mag.* 1832 (*sub* Leuchæria) = Chabræa rosea, *DC. Prod.* "Plant with thistle-shaped leaves; flowers a pale mauve; grows in thick woods on eastern slope of the Cordillera; attains a height of about 3 feet." —*W. Andrews.* This is an Andine species which has descended for some distance on both slopes of the great range.

101. Leuceria achilleifolia, *Hook. et Arn. Comp. Bot. Mag.* ii. 43 (*sub* Leuchæria) = Chabræa multifida, *DC. Prod.* "Plant growing in sandy soil; flowers a pale mauve."—*W. Andrews.* The original specimens from which this species was described were collected by Darwin at Port Desire. DeCandolle founded his *Chabræa multifida* on a specimen from the same place collected by Née. It may be doubted whether several of the described species of this group should not be united. The specific name, as well as the generic, proposed by Hooker and Arnott is entitled to precedence.

78. Perezia recurvata, *Less.* = Homoianthus echinulatus, *Cass.* = Perdicium recurvatum, *Vahl.* "Small low-growing plant; blossom bright blue; found amongst mountains in sandy and stony districts."—*W. Andrews.* This species has been supposed to be confined to the Magellanic region. It may be inferred from the above note that it extends some way northward towards the base of the Andes.

54. Nassauvia rosulata = Acanthophyllum rosulatum, *Hook. & Arn. Comp. Bot. Mag.* ii. 43. "Low creeping shrub growing in clumps on high gravelly clay or rocky plateaux. Not found till south of the Senger."—*W. Andrews.* Although not in flower or fruit, there can be no doubt as to the identity of this singular species, as to which I have given some particulars in the 'Journal of the Linnean Society,' Bot. xxi. p. 225.

Vacciniaceæ.

86. Pernettya ——? "Shrub of low compact growth; berries of a wax-like appearance shading from pink to white; found near streams or near trees in the neighbourhood of the Andes."—*W. Andrews.* The single small specimen resembles most *P. mucronata,* Gaudich., but cannot, I think, be referred to that species.

Plumbagineæ.

82. Statice brasiliensis, *Boiss.* "Plant growing in moist low ground, and always indicates the presence of *salitre* (salt and nitrate of soda) in the soil. The flower is lightish blue verging to pale pink or white. The root is large and long like that of the dock. Boiled in water it gives a decoction of a dark brown colour and salt taste. It is an invaluable remedy for all internal bruises, tumours, &c. Local name 'Wykeru.'"—*W. Andrews.*

It is impossible not to suspect that the species of this group found on both coasts of the western hemisphere should all be referred to the original *Statice Limonium* of Linnæus. Along with *S. caroliniana*, Walt., inhabiting the eastern coast of North America from Newfoundland to South Carolina and Texas, Boissier has described in DeCandolle's 'Prodromus' *S. californica* from the Pacific coast, and *S. brasiliensis*, which extends on the east coast of S. America from the neighbourhood of Rio Janeiro to Southern Patagonia. To these Philippi has added a fourth species, *S. chilensis*, Linnæa, xxxiii. 220, apparently a rare plant which he had received from only one locality. Of the forms here enumerated the first is the most different from *S. Limonium*, but Boissier's *S. californica* is, in many respects, intermediate. The characters assigned to these species are scarcely sufficiently stable, and may most of them be paralleled among the undoubted varieties of *S. Limonium* from different parts of Europe and the Mediterranean region. Boissier is disposed to attach importance to the presence or absence of hairs upon the calyx-tube, but I find this character to be very variable. In some specimens of *S. californica* the calyx is quite glabrous. I have not seen authentic specimens of *S. chilensis*, unless a specimen from Coquimbo and another from Valparaiso in the Kew Herbarium should be referred to it. Both specimens are quite immature with the flowering branches undeveloped, but are not distinguishable from *S. Limonium*. The branches of the panicle in *S. brasiliensis* are described as scabrous; in Mr. Andrews's specimens the branches in the dried state are rough, but certainly not scabrous.

Loganiaceæ.

118. Buddleia globosa, *Lam.*, var. foliis subtus albo-tomentosis. "Local name *Retamilla*. Grows in abundance on slopes of the pre-Cordillera. I have plants of this raised from seed I sent to England in 1882."—*W. Andrews.* This is, I believe, quite new to the eastern side of South America. All the other specimens I have seen are from Chili; and in these the lower surface of the leaf is covered with a reddish-brown tomentum.

Asclepiadeæ.

35. Philibertia Gilliesii, *Hook. et Arn.*=Sarcostemma Gilliesii, *Decne. in DC. Prod.*=S. incanum, *Decne. l. c.*=S. Do-

nianum, *Decne. l. c.* "Creeper, found on high ground and amongst shrubs of table-lands; flowers a round bell-shape, of a dirty white, mottled in the interior with very small spots of purple; foliage a bright green."—*W. Andrews.* This is not a creeper, but a climbing plant with weak branches that twine round any support, or, failing such, round each other. It seems to extend over a wide area on the eastern side of South America.

26. Asclepias linifolia, *Decne.* "Plant bushy; fleshy foliage of a bright green; flowers a greenish white. The stem, when broken, yields an immense quantity of an acrid milk-like fluid; height about 10 inches; grows in a clump in clay grounds, and generally indicates the presence of *salitre.*"—*W. Andrews.* I am unable to distinguish the limits of the species nearly allied to *A. mellodora*, St.-Hil., which are widely spread on the eastern side of temperate South America.

Convolvulaceæ.

111. Cressa cretica, *L.* "Small plant; silver-grey foliage and whitish flowers; found in the island of St. Blas; soil sandy."—*W. Andrews.* In these specimens of this cosmopolitan species the fruit is larger than usual. See the remark in Benth. et Hook. f., 'Genera Plantarum,' ii. p. 881.

Solanaceæ.

15. Nierembergia rigida, *Miers.* "Plant found in abundance on dry sandy or gravelly plains. These specimens were collected about 7 leagues to the S.W. of the Bahia St. Blas. Flowers a pure white, with purplish veins, and an eye of the same colour."—*W. Andrews.* Though not without doubt, I am disposed to agree with Grisebach ('Symb. ad flor. Argent.' p. 242) in uniting *N. filicaulis*, Lindl., with *N. rigida.* A specimen labelled by him *N. filicaulis* undoubtedly belongs to *N. rigida.* This species seems to extend from Paraguay and the Province of Mendoza to North Patagonia. Some caution is necessary in endeavouring to ascertain the geographical distribution of South-American plants. This species and *N. linifolia*, Miers, are included in the 'Flora Chilena,' though not, as I believe, found further west than the neighbourhood of Mendoza. In DeCandolle's 'Prodromus' Decaisne has described a plant as from South Brazil, adding that the specimens came from the banks of the Rio Negro of Patagonia.

74. Fabiana imbricata, *Ruiz et Pav.*? "Shrub, attaining a height of 10 or 12 feet; grows in sandy soil, and most luxuriant in neighbourhood of Nahuel Huapi, a lake on eastern side of the Andes."—*W. Andrews.* The specimen is without flower or fruit, but it is scarcely possible to mistake this characteristic Chilian species. I have seen no other specimens from the eastern side of the Andes.

23. Nicotiana angustifolia, *Ruiz et Pav.*=Petunia acuminata, *R. Grah.*=Nicotiana acuminata, *Hook. Bot. Mag.* t. 2919. "Plant growing to a height of about 4 feet; long slender-throated flower, opening with a cup; flower yellow; soil clay; found on low-lying plains."—*W. Andrews.* There is, I think, no doubt as to the identity of the species described by Graham with that of Ruiz and Pavon. As Remy remarks, the figure in the 'Flora Peruviana' is ill-executed and misleading. The species is found on both sides of the Andean chain, but is more common in Chili.

39 and 112. Solanum eleagnifolium, *Cav.* "Dwarf shrub, with glaucous foliage and yellow spines; flower of a pale lilac, somewhat resembling that of the potato; fruit a small round yellow berry, with seeds inside; locally called *Manzana del Diablo.* Height from 6 to 15 inches, generally found in clay ground in the valleys of Rio Negro, Chubat, &c."—*W. Andrews.* This species has a wide range in subtropical and temperate South America, being equally common on both sides of the Andes.

Scrophularineæ.

81. Calceolaria plantaginea, *Sm.*?=C. biflora, *Lam.*? "Broad-leaved *Calceolaria*, found at foot of the mountains. The leaves grow in a compact mass close to the ground. The flowers shoot up on stalks, much as the Cowslip."—*W. Andrews.* The specimen consists of a single leaf and two detached flowering scapes each bearing three flowers on very long filiform peduncles. I do not feel assured of the identity of the species. *C. plantaginea* is found in many places in the Chilian Andes, and extends southward to West Patagonia, but does not approach the Atlantic coast.

44. Linaria canadensis, *Dum.-Cours.* "Plant found on margin of Rio Negro, generally on gravel-banks; flowers of a

pale purple."—*W. Andrews.* Widely spread through the temperate regions of North and South America.

109. Mimulus luteus, *L.* "Yellow blossom, grows in moist localities."—*W. Andrews.* This polymorphous plant, of which several varieties have been described as distinct species, is also common to the northern and southern temperate regions of America.

53. Scutellaria nummulariæfolia, *Hook. f.* "Small plant growing in moist valleys; flower deep purple with white centre."—*W. Andrews.* This species has hitherto been found only on the shores of the Straits of Magellan.

Verbenaceæ.

22. Verbena bonariensis, *L.* "Plant with tall upright stem to a height of from 4 to 6 feet; very small deep-purple blossoms in clusters at point of long stems. Decoctions of this are much used to bathe bruises. Foliage of a dark green, and rough to the touch. Grows in clayey ground, especially near streams, lakes, &c."—*W. Andrews.* This species appears to be a genuine cosmopolite, extending to the warm temperate regions of the earth, though doubtless in many stations (for instance, the Canary Islands) it has been introduced by human agency.

47. Verbena tenera, *Spreng.*=V. pulchella, *Sweet*=V. Berterii, *Schau.* "Plant with growth similar to *Verbena*; flowers white, also lilac; generally found in clayey soil."—*W. Andrews.* I have no doubt that *V. Berterii* is one of the forms of Sprengel's *V. tenera*, a species very widely spread in South America. A revision of the species of this group, with the assistance of more abundant materials than those which were at Schauer's disposal, would, I think, lead to a great reduction in the number of admitted species.

68. Verbena thymoides, *Phil., sec. schedam in Herb. Kew.*? "Tuft of a small, low and compact-growing plant, having an aromatic flower like thyme; flowers white, sometimes tinged with purple. Grows chiefly on high dry soil and amongst rocks." —*W. Andrews.* A plant which appears identical with this was collected at Port Desire by Darwin. It can scarcely be separated from a Chilian plant bearing the label above quoted; but I have

seen no published description. Very near to this, and perhaps an extreme form of the same species, is *V. bryoides*, Phil., Fl. Atac. 40.

PLANTAGINEÆ.

95. PLANTAGO BRIDGESII, *Decne.*, var. ANGUSTIFOLIA, *Oliver*, *MSS.* "Plant found on clay or sandy plain; minute purplish flower?"—*W. Andrews.*

CHENOPODIACEÆ.

40. ATRIPLEX CRISTATA, *Moq.*, var.? "Creeping plant of a vivid green foliage, common throughout Patagonia; emits a strong pungent odour when bruised."—*W. Andrews.* I much doubt whether *A. Pamparum*, Griseb., which appears to be common in the Argentine pampas, can be separated from *A. cristata.* This has a wide range in America, extending to the Southern United States.

PROTEACEÆ.

87. EMBOTHRIUM COCCINEUM, *Forst.*, var.? "Found on slopes of Andes in sheltered vales; of free high growth; blossoms red, shading in parts to yellow."—*W. Andrews.* Professor Oliver is doubtfully disposed to refer this to the *E. lanceolatum*, Ruiz et Pav. The specimens are very incomplete, and only a few flowers are developed. When better known, this may be found to belong to an undescribed species. *E. coccineum* is common in the Magellanic region and the southern extremity of the continent. *E. lanceolatum* has hitherto been found only in Chili.

LORANTHACEÆ.

110. LORANTHUS ——? an L. tetrandrus, *Ruiz et Pav.*? "Shrub found growing in woods of the slopes of the Andes; blossoms dark red."—*W. Andrews.* This very imperfect specimen is doubtless very near to the Chilian *L. tetrandrus*, which is a common parasite on the western slopes of the Andes, but has not hitherto been found elsewhere.

SANTALACEÆ.

97. QUINCHAMALIUM MAJUS, *Brongn.* "Plant growing in sandy soil; many small heads of yellow in a close clump."—*W.*

Andrews. As the authors of the 'Genera Plantarum' remark, it is very difficult to define the limits of species in this genus, and therefore to discuss their geographical distribution. *Quinchamalium majus* certainly extends to both sides of the Andean chain.

76. ARJONA PATAGONICA, *Hombr. & Jacquinot.* "Plant of low growth, on sandy and stony ground in mountain-districts; pale purple flowers in tufts."—*W. Andrews.* This is a characteristic species of the Magellanic region, which extends some way north in Patagonia, but apparently does not reach Southern Chili.

EUPHORBIACEÆ.

18. EUPHORBIA PROSTRATA, *Ait.*? "Creeping" [should be prostrate] "plant, growing most luxuriantly in stony clay ground; small yellow flowers."—*W. Andrews.* This cosmopolitan species is closely allied to the Old-World *E. Chamæsyce.* I was disposed to refer the present plant to *E. Engelmanni*, Boiss. in DC. Prod. xv. II. p. 42, which has been found abundantly in Argentaria and Uruguay; but that species is distinguished by fimbriate stipules, which Mr. Andrews's specimens do not seem to possess.

CUPULIFERÆ.

80 and 117. FAGUS OBLIQUA, *Mirbel.* "Leaves of tree of large size; rough bark: eastern slopes of the Andes."—*W. Andrews.* Although leaves only have been sent, there can scarcely be any mistake as to the species. It extends to both slopes of the Andes.

67. FAGUS ——? "Leaves of a tree of large size picked on the shores of Lake Lajara at beginning of autumn, at that time of an intense red colour."—*W. Andrews.* Professor Oliver is disposed to refer these leaves to *F. procera*, Poepp. et Endl.; but they appear to me quite uncertain.

AMARYLLIDEÆ.

10. ZEPHYRANTHES ANDERSONI, *Herb.* "Crocus-like flower, of a bright magenta colour, rising from the bulb; foliage very rare. Found all over the plains of Patagonia, slopes of the pre-Cordillera, and even up among the perpetual snows of the true Cordillera. I have gathered specimens on the Quattropillan at a

height of 3440 metres. Occasionally two flowers are found on a single stem, one slightly below the other. Local name *Margarita rosada*."—*W. Andrews.*

11. ZEPHYRANTHES ——?, an sp. nov.? "Small yellow Crocus-like flower; bulbous root; found in gravel, sand, and clay; height about 4 inches. The flower is generally without foliage; when present, this consists of two, rarely more, thin grass-like leaves."—*W. Andrews.* Mr. Baker pronounces this to be near *Z. filifolia*, Herb. inedit., and probably a new species.

104. HIPPEASTRUM ——? "Grows abundantly on grassy plains; flower white, varying to purplish carmine."—*W. Andrews.* A single flowering scape, without root or leaves.

GRAMINEÆ.

89. MELICA RIGIDA, *Cav.* This species seems to be confined to the east side of temperate South America.

45. BROMUS UNIOLOIDES, *Kunth.* "Grass picked near river in vicinity of Guardia Pringles."—*W. Andrews.* This grass is common throughout the greater part of South America.

FILICES.

51 and 60. ASPIDIUM CORIACEUM, *Sw.* Both specimens were collected near Port Desire. A cosmopolitan species, but chiefly limited to the southern hemisphere.

STUDIES IN VEGETABLE BIOLOGY.—VI. An Investigation into the True Nature of Callus:—The Vegetable-Marrow and *Ballia callitricha*, Ag. By SPENCER LE M. MOORE, F.L.S.

[Read 6th March, 1890.]

(PLATE XIV.)

HISTORICAL INTRODUCTION.

DISCOVERED rather more than half a century ago by Th. Hartig *, and studied, among others, by such renowned botanists as Von Mohl, Nägeli, Hanstein, De Bary, Janczewski, and Strasburger, there is yet some doubt, not indeed concerning the morphology of sieve-tubes, for that has been the subject of many a fine memoir, but doubt as to the nature of the substance found so constantly upon the sieve-plates, and which, since the appearance of Hanstein's † monograph, has been known as *callus*. And not only this, but two distinctly opposite views are yet held as to the origin of this substance, one being that it is formed by simple swelling-up of the sieve meshwork itself, with subsequent coalescence of the swollen portions into a continuous mass; while, according to other authors, callus owes its origin to the protoplasm, or, to speak more correctly, the slime of the sieve-tubes, which deposits it upon the sieve-plates. To follow this latter subject, first: the older writers, such as Von Mohl ‡ and Nägeli §, may be claimed as advocates of the former of these views; for they seem to consider the sieve itself as the "middle layer" of the intertubal wall, the two callus-plates forming the wall proper. The next writer on the list, De Bary ‖, with his usual caution, refuses to dogmatize on the subject, remarking that it requires further investigation. Three years after the publicatiou of the 'Vergleichende Anatomie' of De Bary, his pupil Wilhelm ¶

* 'Fortschritte der Forstwissenschaft,' 1837. I have not seen this publication.

† 'Die Milchsaftgefässe und die vorwandten Organe der Rinde,' 1864.

‡ Bot. Zeitung, 1855.

§ Sitzb. der k. bayer. Akad. der Wiss. zu München, 1861.

‖ Vergl. Anat., Engl. transl. p. 175.

¶ 'Beiträge zur Kenntniss des Siebröhrenapparats dicotyler Pflanzen,' 1880.

published an elaborate monograph on the sieve-tubes of *Vitis vinifera*, *Cucurbita Pepo*, and *Lagenaria vulgaris*; in this Wilhelm expresses his conviction that callus is altered cell-wall; and this view was acquiesced in by Janczewski * shortly afterwards. In 1882 we find the opposite idea broached by Russow †, who takes his stand upon the ground of the difficulty of reconciling the disappearance of callus in spring-time with clearing of the sieve-plates, that is, their return to the primitive condition—the difficulty of reconciling this with the origin of callus by swelling-up of the wall of the sieve, which ought, if the older view be correct, to show at least some signs of waste in consequence. It is true that Janczewski looked upon the process as one of hydration—the callus swelling up in autumn, a time when the watery reserves in the plant tend to increase, and condensing and contracting by loss of water on the return of spring. But this is obviously unsatisfactory; for it may be remarked that were this idea correct, we ought to find callus diminishing in quantity proportionally to the withdrawal of water from the plant, and callus ought not to make its reappearance until quite late in the year. Russow ends a strong argument by remarking that all difficulties will vanish if it be admitted that callus consists of contents of the sieve-tube deposited upon the sieve-plate.

Strasburger ‡ came to Russow's support in 1884; and in the same and also following year Gardiner § declared himself upon the same side: his example was followed by Fischer in 1886 ||.

On the other hand, we find F. W. Oliver ¶, in 1887, reverting to the older view, his conclusions being founded on careful study of the remarkable deposits of callus in *Macrocystis* and *Nereocystis*. Finally, Lecomte ** has expressed himself in the same sense.

* Mém. de la Soc. des Sc. Nat. et Math. de Cherbourg, t. xxxii. 1881. (Also an extended extract of this in Ann. Sc. Nat. Bot. 6 sér. t. xiv.)

† Sitzb. der Dorpat. naturforsch. Gesellsch. 1882. Translated in Ann. Sc. Nat. Bot. 6 sér. t. xiv. This was the idea of Hanstein (Milchsaftgefässe).

‡ 'Bot. Practicum,' ed. 1 (1884).

§ Proc. Camb. Phil. Soc. 1884, p. 102; *ibid*, 1885, p. 230.

|| Ber. d. deutsch. bot. Gesellsch. 1885, and Ber. üb. d. Verhandl. d. k. sächs. Gesell. d. Wiss. zu Leipzig, 1886; abstract in Bot. Zeitung, 1886, and in Journ. R. Micros. Soc. (same year).

¶ Ann. of Bot. vol. i.

** Bull. Soc. Bot. de France, t. xxxv. (1888), and Ann. des Sc. Nat. 7 sér. t. 10 (1889).

A third view has recently been propounded by Rendle *, who, by a thorough examination of the Onion, believes the callus in this plant to owe its existence partly to the wall, partly to the protoplasm.

It is necessary to give this brief historical *résumé*, because, as will hereafter appear, some of the facts brought forward in the present memoir are, it is believed, of such a nature as to put an end, once and for all, to the conflict in opinion which has prevailed upon the origin of callus, so far at least as regards the two types here dealt with.

With reference to the other matter, viz. the nature of callus, we find De Bary † noting the yellow colour it takes with iodine dissolved in potassium iodide, its swelling in hydric sulphate till its outline is completely lost, and its swelling up in caustic potash. Russow ‡ appears to have been the first to hazard an opinion as to the chemical constitution of callus: having hit upon the method of staining it with aniline-blue, and also with that mixture of iodine and Schulze's solution now known as Russow's reagent, he remarks § that it is proteids, and especially nuclein, that callus most closely resembles. Unfortunately, just at this time Szyszylowicz ‖ discovered the brilliant colour taken by callus in corallin-soda—a fact which set observers upon a wrong tack altogether. It was assumed that because starch and mucilage both take up corallin-soda, because the protoplasm of the sieve-tubes undergoes, after the disappearance of the nucleus, a change into slimy matter, and because this change is accompanied by solution of the starch, for these reasons it was assumed that callus is a sort of starchy mucilage. This idea is, at least as far as the facts hereafter brought forward go, a wholly incorrect one; and I will now proceed to defend this statement.

* Ann. of Bot. vol. iii.

† Vergl. Anat. Engl. Trans. p. 175.

‡ Sitzb. der Dorpat. naturforsch. Gesellsch. 1881.

§ *L. c.* (1882 memoir).

‖ *Vide* Janczewski, *l. c.* (Note Additionelle). Also a Polish memoir by Szyszylowicz, which I have not seen, but which is abstracted in Bot. Centralblatt, Band xii. p. 138.

Proteid Reactions of the Callus of the Vegetable-Marrow.

The material used in this research was taken from a Vegetable-Marrow plant at the fag end of the season; by this means a plentiful supply of callus was ensured, irrespective of any which might be formed by cutting of the stem in pieces and by its preservation in alcohol, which, as Fischer * has shown, are methods very apt to increase the amount of "Schlauchkopf" and of callus in the sieve-tubes. Fischer † has described "ectocyclic," "entocyclic," and "commissural" sieve-tubes in *Cucurbita*, in addition to those of the vascular bundles; my observations refer to the latter alone.

The three chief tests for proteids are the xanthoproteic reaction, depending upon the deep yellow colour produced on boiling with nitric acid and after-addition of ammonia, the red coloration imparted by Millon's reagent upon warming, and the blue or blue-pink by copper sulphate and caustic potash or soda, the latter becoming deeper on boiling. Unless a substance gives all these reactions, it cannot be considered to be a true proteid; if all three are yielded by it *in the typical way*, the presumption is that protein is present.

There is no difficulty whatever in getting the xanthoproteic reaction, if only the precaution be taken of adding an excess of ammonia. The method pursued throughout the research where boiling was necessary was the following:—Sections were mounted in the fluid appropriate to each case; a cover-slip was then put over them, and heat was applied by means of a spirit-lamp. If much of the fluid evaporated before the desired effect was obtained, more was run in, the process being continued as long as was deemed essential. The advantage of this method is that the operator always has his material well in hand, and so can prevent over-boiling—a very important matter, as will afterwards appear. In testing with nitric acid and ammonia, then, it is necessary that the latter be in excess: the effect of boiling is usually to cause some swelling of the callus, but not much; it frequently happens that the sieve-piercing connecting threads are brought beautifully into view by this means. The colour, which is a well-pronounced yellow, is markedly deeper than that,

* Ber. d. deutsch. bot. Gesellsch. 1885.

† 'Unters. üb. d. Siebrohrensyst. d. Cucurbitaceen,' Berlin, 1884. Abstracted in Journ. R. Micros. Soc. 1885, p. 477. I have not seen Fischer's memoir.

assumed by the slime, as will be noticed on a reference to fig. 1 of Plate XIV. There is one point in which this reaction is more satisfactory than the others, inasmuch as it readily admits of the preservation of the tissue treated by it; the specimen shown to-night has been mounted in glycerine for several months, and its colours are still as brilliant as ever.

Millon's reagent acts with Vegetable-Marrow callus as clearly as does the just-mentioned test. To obtain it, however, care must be taken to avoid over-boiling; indeed, the best effect is got at temperatures just below boiling; but if boiling be continued even for a minute, the red colour is liable to disappear (Plate XIV. fig. 2).

But it is more difficult to prove that, in respect of the third test, Vegetable-Marrow callus comes within the proteid group. If previous observers have tried this reaction, their failure is scarcely blameworthy on the score of remissness; for who would dream of upwards of an hour elapsing before the effect is brought about? And yet this is indeed sometimes the fact. You mount the sections in copper sulphate, and, after a little time, run in caustic potash, but in almost all cases without any result for at least ten minutes. Then perhaps a callous mass at the edge of the preparation will become very pale pink or bluish; this will gradually deepen into the colour of Plate XIV. fig. 3, or will become lavender; after a few minutes two or three more will follow suit, until, finally, all are coloured. But it may happen that one hour, or sometimes even half as long again, must elapse before the slightest change is caused in any of the callous masses. Why this lapse of time should occur is difficult to understand: possibly the method is at fault; and there may be some way of rapidly getting the reaction; but if there is, it still remains to be discovered.

All the above-mentioned reactions were given in a very clear manner by the slime of the sieve-tubes. The only difference observed was that the respective colours were less pronounced, in consequence, apparently, of the less dense aggregation of the slime as compared with the callus.

Reactions of the Wall of the Sieve-tubes.

(a) *Proteid Reaction.*—Throughout the research this matter was carefully attended to: the reason for this will be explained

hereafter, when treating of *Ballia callitricha* *. The only proteid reaction yielded by the sieve-tube tissue was the xanthoproteic; but I could never find a trace of reddening with Millon's reagent, nor did copper sulphate and caustic potash or sugar and sulphuric acid tinge the walls to the slightest extent.

(b) *Cellulose Reaction.*—On the other hand, the walls of the sieve-tubes and cambiform and companion cells give the purple colour with Schulze's solution, by which cellulose is known. The slime and callus are coloured brown by this reagent.

Action of a Peptonizing Fluid upon Vegetable-Marrow Callus.

Vegetable-Marrow callus thus gives, in the most distinct way, the chief reactions employed in the detection of proteids. And here arises a question of some interest, namely, whether this callus-proteid resembles the main body of proteids in being acted on by pepsin and typsin in an acid and alkaline medium respectively with formation of peptone; or whether, like lardacein, it is able to withstand the action of proteolytic ferments. In order to answer this question, experiments were arranged in the following way.

Into the first of four vessels was placed some artificial gastric juice prepared according to Pharmacopœia directions, and some radial or tangential sections of the phloëm of the Vegetable-Marrow. The second vessel contained some gastric juice with finely-chopped meat; this was to serve as a test of the goodness of the pepsin. Sections of phloëm with some 0·2 per cent. solution of hydrochloric acid were in the third vessel; the object of this was to ascertain whether the acid alone would have any action upon the callus; and, if any, what action. The fourth vessel contained distilled water alone. All four vessels were then exposed to temperatures varying between 35°–39° C. From the second vessel the peptone reaction was obtained after a little time, thus showing the genuineness of the pepsin. Sections from the first vessel were examined from time to time; and it soon became evident that dissolution was in progress. So much was this the case, that at the end of $8\frac{1}{2}$ hours a considerable part of the callus had already disappeared; while after 16 hours no trace of it remained upon the sieve-plates. The sieves were now

* *Vide infrà*, p. 514.

perfectly open, just as at the beginning of the vegetative period, and they gave the purple colour with Schulze's solution. It has not been thought necessary to draw the stages of this process; but anyone who wishes to see figures of what occurs will be able to satisfy his curiosity by referring to tab. 9 of Janczewski's memoir *, where dissolution of the callus of *Aristolochia Sipho* at the beginning of the season is beautifully figured. Fig. 10 on Plate XIV. shows the sieves cleared of their callus: in this case the action was allowed to continue for 30 hours, by which time neither the callus in the acid solution, nor that in the water, had been in any way affected.

In this second point, therefore, we see that the callus of the Vegetable-Marrow agrees with the great body of proteids. We have already found Russow drawing a parallel between callus and proteids, on account of the behaviour of the former to iodine and to aniline-blue; and there can be no doubt but that Russow was upon the right clue, and that the starchy-mucilage view must, at least so far as relates to the Vegetable-Marrow, be definitively abandoned †.

It is to be presumed that peptone is formed as the result of the digestion of callus; but this I was unable to ascertain, apparently because of the extremely small amount of callus dealt with. It would seem that to get the peptone reaction with clearness, a much larger quantity of callus than I had must be employed.

Origin and Classification of Vegetable-Marrow Callus.

The chief objections which have been urged against the swelling-up theory of callus-formation are, that the edge of the sieve is always visible, although plenty of callus may be present; that in the progress of obliteration the connecting channels, at first relatively broad, become thinner and thinner, the sieve-plate meanwhile not itself increasing in size ‡: and in connection with this, Russow § noticed that the rod-like striæ visible in callous masses

* Mém. Soc. Sc. Nat. Math. Cherbourg, xxxii. (1881).

† Gardiner also at first supported Russow (Phil. Trans. 1883, and Proc. Camb. Phil. Soc. 1884, p. 101); but he afterwards changed sides (Proc. Camb. Phil. Soc. 1885, p. 230). Hillhouse (Midland Naturalist, 1884, p. 122, note) notices some resemblance, "probably, however, merely casual," between the reactions of callus and those of nuclein.

‡ Fischer, 1886 Memoir. Figs. 30–32 of this memoir are very instructive.

§ Sitzb. Dorpat. Naturf. Gesellsch. 1882.

upon treatment with iodine surround threads of slime, and, according to Fischer, this is due to conversion of the slime into callus, the process taking place from without inwards. In addition to this, it has always been a stumbling-block in the way of adherents to the other theory, that the sieve-plates of many perennial plants are cleared in the spring. This one cannot understand as happening if the callus be merely transformed sieve-plate; and, besides this, as already mentioned, Fischer finds an increase in the amount of "Schleimkopf" and callus from mechanical injury and from preservation in alcohol, which is explicable on the deposition theory alone *. However, although, in my opinion, the latter theory has always been the stronger, the battle between the two views has necessarily been a drawn one, because continuous observation of a sieve-plate was impossible. But in the new method of employing a peptonizing fluid we have the means of keeping under observation one and the same sieve-plate, which we can see gradually clearing, and, finally, quite free from callus. We can then examine a sieve-plate which but a few hours previously was obliterated with callus, and find it in exactly the same condition as before callus made its appearance upon it. And when we remember that the callus is, at least in the Vegetable-Marrow, undoubtedly a proteid, and, as such, cannot possibly be formed from cellulose, it is submitted that the question is definitively settled, so far as the Vegetable-Marrow is concerned.

With what class of proteids should Vegetable-Marrow callus be assorted? To answer this question, it is necessary to know its behaviour to neutral saline solutions: those employed in this research were sodium chloride and potassium nitrate, in each case in 1 per cent., 10 per cent., and saturated solutions. In no case did the callus betray any tendency to dissolve. From its insolubility in water and in neutral saline solutions, as well as in dilute acids and alkalies, while it dissolves in strong hydric sulphate, and, to some extent at least, in caustic potash, Vegetable-Marrow callus recalls, and may perhaps be classified with, the Coagulated Proteids.

* Here, too, one may mention Janczewski's observation, that sometimes the sieve-tubes of old rhizomes of *Phragmites communis* have their sieves open in winter. This is supposed by Janczewski to be due to the tubes no longer containing protoplasm. But why should disappearance of the protoplasm prevent formation of callus, if mere swelling-up of the wall is involved?

A Short Account of Ballia callitricha, *Ag.**

The thallus of *Ballia callitricha* consists of a main axis composed of a single series of cells, each of which bears on either side a secondary axis, of which the basal cell is formed near the upper end of the parent-cell: these secondary branches lie in two series, the individual members of both series lying in the same plane as their predecessors. Each secondary branch, in its turn, branches in the same way as its parent; and so with branches of later order; and the whole of the ramifications lie in one plane: the plant therefore consists of a series of systems of superposed binary verticils all with their median plane coinciding. This arrangement is afterwards complicated by cortication of the axis, which commences by downward growth of the basal cell of each branch.

The septa between contiguous cells of the same order of ramification are saddle-shaped, the side of the saddle being visible in the ordinary view. This accounts for the peculiar appearance of each septum, from which one might conclude that the upper cell intrudes upon the lower, whereas, as Archer † first showed, precisely the reverse is the case. The saddle is shown in Plate XIV. fig. 4; in the other figures it has been thought sufficient to draw its upper part alone.

At this upper (central) part are situated the remarkable bodies known since the date of Archer's paper as "stoppers": these are highly refractive as seen in dried specimens moistened, and more or less hemispherical in shape with a flat base by which each is applied to a sort of bed of cell-wall. There is, however, no adhesion between stopper and wall, for the former can easily be detached from the latter, under which circumstances, if the means taken to separate them have not been too violent, the stopper may be seen to be hanging by plasmatic threads to the bed. By appropriate means (Schulze's solution, xanthoproteic test, Millon's reagent, hydric sulphate, Schulze's macerating fluid) a single plasma-bridge or several threads of plasma can be seen running from stopper to stopper; these threads do not appear to traverse the stopper itself but to run out to its edge, and by this means neighbouring protoplasts are put in communication.

* *Vide* Archer in Trans. Linn. Soc., 2nd series, Bot. vol. i.

† *Loc. cit.*

The phycoerythrin of the cell is, of course, soluble in water, but in dried specimens I find many of the cells without any trace of colouring-matter. The cell-protoplasm of dried specimens moistened is very often most beautifully reticulate; this reticulation is only exceptionally seen in young cells, but it is common in older ones; indeed it is rare to find one of these cells without some trace at least of a reticulum. The meshwork may be tolerably even, or it may consist of large meshes with narrow bars in one part of a cell, and of smaller ones with thick bars in other parts, or both forms may be mixed. It frequently happens that the protoplasm is aggregated near one end or near both ends of the cell *; starch-grains of varying size are present in the meshwork. I have been unable to find a single nucleus in these cells—hæmatoxylin and acetic methyl-green stain in every cell several small bodies in the way characteristic of nuclei, and hence it is to be presumed that we have really to do with syncytia; but it is scarcely safe to dogmatize upon the minute structure of the cells of a plant which has undergone desiccation.

Reactions of the Stoppers.

The stoppers react in the following ways:—

Acetic Acid has no effect upon them whatever, neither has strong *Nitric* nor *Hydrochloric Acid.*

Strong *Hydric Sulphate* causes slight swelling, but so slight as to be often almost inappreciable.

Hydrochloric Acid gives no red coloration to the stoppers, neither before nor after they have been soaked in a solution of *phloroglucin*.

Carmine preparations: of these three were used—*picrocarmine*, which imparted a yellow colour, and *Beale's* and *Thiersch's carmine*, which had no effect.

Caustic Potash when cold may cause very slight swelling, but sometimes none at all; when not, dissolution is involved, but without exudation of yellow drops.

Fuchsin stains the stoppers brilliantly and permanently; this I find also to be the case with ordinary callus.

* This was noticed in my memoir on Protoplasmic Continuity. (This Journal, vol. xxi.)

With *Watery Eosin* the stoppers are coloured a bright and permanent pink; *Hæmatoxylin* also stains them bright red.

Iodine dissolved in potassium iodide gives a rich brown colour, similar to that given by Russow's reagent. Schulze's *solution* also colours brown and without swelling the stoppers.

Corallin-Soda stains beautifully, but, as is the case with ordinary callus, the colour soon fades, and after a time disappears entirely.

Sands's Picric Blue.—This is the aniline blue referred to in my memoir on Protoplasmic Continuity. It is an admirable reagent for callus, which it stains a peculiar blue, a blue much lighter than that taken by protoplasm. Curiously enough, the stoppers scarcely ever show any sign of blueing. A slight local stain may occasionally be seen upon them, but this is probably due to the protoplasm of the cell; from the reagent in question, the stoppers take up picric acid alone, becoming yellow in consequence.

On running over the list of reactions, the resemblance in most essential points between *Ballia* stoppers and Vegetable-Marrow callus will at once be realized, and this is further emphasized by resemblance in optical properties, both substances being isotropic. The chief differences are:—

1. Insolubility of the stoppers in strong hydric sulphate.
2. The rich brown with iodine.
3. Refusal to take up aniline blue.

Of these, the first is obviously immaterial in its bearing upon the proteid nature of the stoppers; the second being a distinctive proteid reaction, is an argument in favour of the proteid nature. Refusal to take up aniline blue is certainly a peculiarity, but I think that when all the evidence in favour of the proteid nature has been marshalled, this solitary reaction will be regarded as of no effect upon the question.

Action of a Peptonizing Fluid upon the Stoppers.

To determine this point, experiments were made in the way already detailed when treating of the Vegetable-Marrow. A remarkable difference in respect of gastric digestion between the stoppers and Vegetable-Marrow callus soon came to light; for instead of gradually dwindling away and finally disappearing, the stoppers gave no sign of the presence of a digestive fluid,

and this even after the lapse of 30 hours, long before which time the callus had all been dissolved away. However, it was deemed advisable to continue the experiment for some time longer; but inasmuch as, after 60 hours, the action of the fluid was still resisted, we can hardly err in coming to the conclusion that the stoppers are not attacked by a peptonizing fluid. Plate XIV. fig. 7 shows a pair of stoppers still unaffected after 30 hours' action of the fluid.

Proteid Reactions of the Stoppers.

We have thus seen the stoppers resisting gastric digestion, hence particular care is necessary in drawing conclusions as to their proteid nature. Our chief guide in this matter will be *similarity in reactions between the stoppers and the protoplasm of the cell* *.

It will be necessary also to attend in some detail to the reactions of the cell-wall. Before entering on the task, however, I may say that the stoppers, both here and in other Florideæ in which they have been studied, have generally been considered as being of proteid, if not of protoplasmic nature †.

Xanthoproteic reaction.—This is very well given indeed; as with the Vegetable-Marrow, it is necessary to have a great excess of ammonia if the reaction is to come off properly (fig. 5). The same colour, only somewhat paler, is given by the cell-protoplasm. Preparations treated in this way preserve their colours perfectly in glycerine.

Millon's reagent produces a fine red-crimson colour in the stoppers, but if boiling be continued above a second or two, the colour flies; it is best got at temperatures a little below boiling. The cell-protoplasm almost always takes a much paler colour, but where the contents are densely aggregated, as so often occurs in the neighbourhood of the stoppers, I have sometimes seen a colour almost, if not quite, as deep as that assumed by the stoppers. Comparison of figs. 2 and 4 will show the different ways in which Vegetable-Marrow callus and the stoppers react to

* This point is insisted on by Fischer in his paper on proteid reactions of the cell-wall (Ber. d. deutsch. bot. Gesellsch. 1887, p. 426).

† Thus Gardiner (Proc. Camb. Phil. Soc. 1884, p. 106) says, *à propos* of the stoppers, "the portion of the pit-protoplasm next the pit-closing membrane is usually well differentiated."

Millon's fluid. One might perhaps, considering this colour-difference and considering too the way in which the bright hue of the stoppers flies if boiling be continued—*a peculiarity, however, which is shared by the cell-protoplasm*—one might, perhaps, regard the crimson of the stoppers with suspicion, the normal colour for proteids being more or less of a brick-red. But it must be remembered that there is much variation in this respect even among typical proteids; thus Krasser * gives the following instances of this fact:—

Albumen	takes a	flesh-red.
Fibrin	,,	carmine.
Legumin	,,	flesh-red to brown-red.
Vitellin	,,	brick-red.

The real reason for the bright colour I believe to be that the stoppers consist of densely aggregated matter and so would necessarily be highly coloured; and this idea is sustained by an already mentioned fact, viz. the deeper hue taken by the more densely aggregated parts of the protoplasm.

Copper Sulphate and Caustic Potash also act very well; the effect is usually got within a few minutes. The colour is usually a pale dirty pink, but sometimes it is pale blue; the former is not a good colour for a proteid, it is admitted, *but precisely the same colour is taken by the cell-protoplasm.*

Raspail's reaction (Sugar and Sulphuric Acid) succeeds very fairly—the colour is a pale brown-pink; the protoplasm behaves similarly.

I have not tried Krasser's † *Alloxan reaction*, since Klebs ‡ has shown it to have no value in the detection of proteids. Neither has *AdamKiewicz's test* been resorted to (violet colour with glacial acetic acid and strong hydric sulphate), for this is said to give too pale a colour to be appreciable under the microscope. There is just a chance, however, in view of the brilliant colour taken by the stoppers with the xanthoproteic and Millon's reactions, that AdamKiewicz's test might succeed with the stoppers.

* Sitzb. d. Wien. Akad. Band 94.

† Krasser, *l. c.*

‡ Bot. Zeitung. 1887.

Reactions of the Cell-wall of *Ballia*.

Xanthoproteic reaction.—This is given very fairly, but not nearly so well as is the case with the protoplasm, and *à fortiori* with the stoppers. *No other proteid reaction is given by the wall.*

Hydrochloric Acid neither alone nor after phloroglucin gives a red colour to the wall.

With *Schulze's solution* local blueing is caused, but the effect is not general even after twenty-four hours. On the other hand, boiling for a minute or two in caustic soda causes the whole wall to take a deep blue-black colour. This points to the presence of cutin in the cell-wall, and the action of Fuchsin mentioned below confirms this idea.

Sands's Picric Blue stains yellow the outer part of the wall of large cells—the inner part taking a dark blue, and the whole, or nearly the whole, of the intercellular septum is so stained.

Watery Eosin stains the wall a brilliant permanent pink.

Corallin-Soda also stains, but temporarily.

Fuchsin colours the outer part of the wall brilliantly and permanently.

Strong Hydric Sulphate causes the inner layers to swell up greatly.

Hæmatoxylin stains the wall the characteristic bluish colour.

We may perhaps suspect from these reactions that there is present in the cell-wall some substance or substances, either of proteid nature or a decomposition product of proteids; but the entire failure of Millon's and the Copper Sulphate and Caustic Potash tests, tells very much against this.

Some other Reactions of Wall, Cell-Protoplasm, and Stoppers.

It is scarcely to be doubted that, as Archer* maintained, and as I have myself also done my best to show †, there is no pit-closing membrane in *Ballia callitricha*. This fact comes out clearly when testing for Millon's reaction, the proteid contents of the pit taking the brilliant colour of the stoppers and no break being observable in the connecting column (Plate XIV. fig. 4). The

* Trans. Linn. Soc. 2nd Series, i.

† Journ. Linn. Soc., Bot. xxi., also Wright, Trans. R. Irish Acad. 1879; Hick, Journ. of Bot. 1884; Massee, Journ. R. Micros. Soc. 1884, &c. For the contrary view see Schmitz (Sitzungsb. d. königl. Akad. d. Wiss. zu Berlin, 1883) and Gardiner (Proc. Camb. Phil. Soc. 1884, p. 104).

effect of boiling for a minute with Millon's fluid is shown at Plate XIV. fig. 8; here the colour has been discharged, but the protoplasmic reticulum (drawn in the lower cell alone) is still visible. The limiting layer of protoplasm comes out now very clearly; it seems to be reflected over the stoppers *, but perhaps the appearance giving rise to this idea is really due to denser consistence at the boundary of the stoppers; at any rate the limiting layer also extends over the bed whereupon the stoppers rest. The latter now have a granular look, in sharp contrast with the uniformly white and apparently homogeneous swollen cell-wall; the granules are evidently precipitated by the reagent, and the protoplasm itself has much the same granular character. The pit is here very well seen with its broad debouching points, and the connecting protoplasm also comes out very clearly.

Another excellent way of studying the relation between stoppers and cell-wall is to use Schulze's macerating fluid. With this, the cell-contents contract after the stoppers have become invisible. Sometimes only one ball of protoplasm is found in the cell, but more often there are several, the spheroidal form greatly predominating; each ball is surrounded by its own delicate membrane, and usually the pit is left quite clear of plasma (Plate XIV. fig. 9, *b*). In other cases, and especially if the action has not been too violent, the connecting protoplasm is still visible (fig. 9, *a*), or there may be two or three threads, this being a consequence of coagulation of the original thread. When, as in fig. 9, *a*, plasma-balls remain in position at either end of the pit, there is no trace of the stoppers; the protoplasm of these balls is still reticulate. But the fact of most interest is that on now running in iodine, the plasma-balls at once take a fine brown colour—colour which is quite as pronounced in these balls into which the stoppers have melted as it is elsewhere; the cell-walls remain uncoloured by the iodine.

Origin and Classification of the Substance of *Ballia* Stoppers.

On the ground therefore:—

1. Of the general appearance of the stoppers, which is so different from that of the cell-wall;
2. Of their distinctive proteid reactions, those of the wall being but feebly shown, if at all;

* Thus Archer describes the stoppers as lying outside the primordial utricle (Trans. Linn. Soc. 2nd Series, i. p. 214).

3. Of their behaviour resembling in almost every point that of the cell-protoplasm, and differing in almost every point from that of the wall;
4. Of the evidence of differentiation as shown by boiling with Millon's fluid—this not being shared by the wall;
5. Of the behaviour of the stoppers with Schulze's macerating fluid, viz. dissolution into adjacent plasma-balls, which subsequently stain brown with iodine while the wall remains colourless;

it seems impossible to avoid the conclusion that, although they resist gastric digestion, the stoppers consist of proteid. It also seems impossible to believe them to be formed by swelling-up of the wall, for why should such marked proteid reactions, and such different behaviour generally, be shown by the swollen portions alone? We have also seen the pit cleared of its plasma and its mouths freed from stoppers; and the appearance of the wall, in this case, is such as to put an emphatic veto on the swelling-up idea. Study of development of the stoppers, so far as it is practicable from dried specimens, teaches the same lesson. Let us look at a young cell—the youngest in which the stoppers are visible: we see here a tiny sphere of substance, looking exactly like the protoplasm and quite unlike the wall, placed at either end of a fine and apparently continuous pit, of which the lumen is occupied by a thread of protoplasm. These spheres we can see increasing gradually in size as we pass away from the growing region, and in no case can the least participation of the wall in this increase be detected. At length after cortication has set in, the stoppers become of relatively enormous size, and frequently have bands of slimy substance attached to them; this substance reminds one of the "Schlauchkopf" of sieve-tubes, but it may perhaps be true protoplasm. The point to notice here is, that not even in these old cells, the stoppers of which give precisely the same reactions as the younger ones, can any swelling-up of the intercellular wall be detected. I see no way therefore of escaping the conclusion that, like the callus of the Vegetable-Marrow, the stoppers owe their existence to deposition at the pit's mouth of proteid matter derived from the protoplasm.

Should the substance of the stoppers—which, like Vegetable-Marrow callus, is insoluble in neutral saline solutions—be included

among true proteids, or relegated to the miscellaneous group of bodies allied to proteids? Bearing in mind that all three proteid reactions are given, I think it would be better to include it among true proteids, where, on account of its resistance to gastric digestion, it will take its place alongside of lardacein. Of the bodies allied to proteids with which the substance might possibly be compared, Mucin gives only two of the proteid reactions—it swells up strongly in water, and is readily soluble in alkalis. Chondrin is soluble in hot water, in alkalies, and ammonia. Gelatine swells up in cold and dissolves in hot water and in weak acids and alkalies, and it has, moreover, extremely feeble proteid reactions. Elastin, with feeble proteid reactions, is soluble in Hydric Sulphate and Hydric Nitrate, whereas Nuclein gives but an indistinct xanthoproteic reaction, and none at all with Millon's fluid. These differences are all of them of such importance, that there can hardly be a doubt of the desirability of not classifying the substance of *Ballia* stoppers with these bodies.

Some General Considerations.

Sachs's * theory that it is in the sieve-tubes that proteids are constructed, has not found much favour. The general view now is that adult sieve-tubes are merely distributors of proteids, not manufacturers of them, for they soon become enucleate †. The notion hinted at by Sachs ‡ seems to be a good one; the callus according to this is interposed as a mechanical hindrance to the passage of the contents of the tubes; in support of this may be cited Briosi's § observation that starch-grains sometimes actually stick in the sieve-plates, as a proof that some mechanical hindrance is necessary. I cannot help thinking that *Ballia* stoppers must function in the same way. What is certain is that the size of the pit increases with the growth of the septum, so the older a cell is, the wider will be the pit separating it from adjacent cells. The lower cells of the main and secondary branches ultimately become of great relative size, and must

* Vorlesungen üb. Pflanzen-Physiologie, Vorlesung. no. xx. (Engl. transl. p. 325). That sieve-tubes are organs for transport of proteid was held by H. von Mohl, Bot. Zeitung, 1855; Nägeli, Sitzb. bayer. Acad. Wiss. 1861; Hanstein, Mitchsaftgefässe; Sachs, Flora, 1863, &c.

† Fischer, Unters. üb. d. Siebrohrensyst. d. Cucurbitaceen.

‡ Vorlesungen, no. xxii. (Engl. transl. p. 361).

§ Bot. Zeitung, 1873.

contain a considerable amount of proteid, though whether proteid is still being manufactured in them I cannot say; but in the oldest cells which came under my observation were to be seen numerous darkly-staining bodies which are most likely nuclei. The branches are arranged in binary verticils, and the basal cell of the branch being considerably younger than the cell of the branch of higher order supporting it, has a smaller pit than the latter cell and smaller stoppers. If the stoppers were not present, what would be the necessary upshot? The cell-contents would wander from one part of the plant to another, the main current flowing through the wider pit; consequently the main flow of proteid would be towards the tip of the main branch, and the plant would tend to form a single, greatly elongated thread. Of course, interposition of stoppers at the pit's mouth of the basal cells of lower-order branches must check the flow along such branches; but the net result will be equalization of the stream, and general distribution to all growing points of the necessary proteids will thereby be ensured.

One may adduce several facts which seem to point to the existence of a callolytic ferment in sieve-tubes. Thus the disappearance of callus from the sieve-tubes of the rhizome of *Phragmites communis* described by Janczewski*—disappearance caused by simply placing the rhizome in a warm chamber during early spring—strikingly recalls the action of a ferment which is inoperative at low temperatures. Again, Russow † notes how in *Pinus sylvestris* and other woody plants the callus dissolves, usually about two years from the time of its formation, by a sort of corrosion, but in certain of the tubes it may remain more or less unaltered, sometimes for ten years; and there can be no doubt that side by side with open sieves, others may occur completely blocked with callus ‡. This one can readily understand by supposing that, for some reason or other connected with the metabolism of the tubes or of the companion cells, ferment has failed to make its appearance in the cells with callus-closed sieves. Again, we know from Russow's § researches, that the callus of sieve-tubes of fallen leaves is not dissolved, and that small portions of starch also remain behind ‖; the complete absence of callolytic ferment in the one

* 'Comptes Rendus,' 1878.
† Sitzb. Dorpat. Naturf. Gesellsch. 1882.
‡ Wilhelm, Siebröhrenapparatt.
§ *L. c.*
‖ Briosi, Bot. Zeitung, 1873.

case and ineffectiveness of amylolytic might explain this, or better, perhaps, the low temperature of the time of leaf-fall. And if there be a callolytic ferment in the tubes, it is easy to understand how, when the cool weather of autumn sets in, it would cease to be effective, and callus would then make its appearance upon the sieves *.

Considerations such as these led me to search for a proteolytic ferment in the sieve-tubes of the Lime-tree. I tried the method of Baranetzky as well as that of Von Gorup-Besanez, but in neither case with success. This is scarcely to be wondered at when it is understood how very small must be the quantity of callus, and hence of ferment necessary for its dissolution, even in an entire tree. Perhaps I did not choose a very favourable subject; and the Hop or *Phragmites communis* might answer the purpose better.

A Short Note on Macrocystis pyrifera, *Ag.*

Discovered in 1881 by Jeffrey Parker † and studied by Will ‡, Wille §, and F. W. Oliver ||, the sieve-tubes and trumpet-hyphæ of *Macrocystis* and *Nereocystis*, and the latter elements of other *Laminariæ*, have been found with their contents in undoubted communication. Oliver has made the interesting discovery of a substance giving the ordinary reactions of callus in the sieve-tubes and trumpet-hyphæ of *Macrocystis* and *Nereocystis* ¶, and he has adduced evidence which leaves but slight doubt, if any at all, that the callus at least of the trumpet-hyphæ is formed by swelling-up of the cell-wall. I have made many experiments with *Macrocystis pyrifera*, and in no case has the slightest trace of proteid reaction been observed; indeed the xanthoproteic is out of the question, for the callus rapidly dissolves in warm nitric

* Sachs (Bot. Zeitung, 1862) finds the contents of the sieve-tubes to be alkaline; hence one would suppose that normal callus-digestion, if it really occurs, is of pancreatic, not of gastric nature, unless, indeed, temporary acidity make its appearance when the sieves reopen.

† Trans. N. Zealand Inst. 1881, p. 562.

‡ Bot. Zeitung, 1884.

§ Kongl. Svenska Vet.-Akad. Handling. xxi, and Ber. d. deutsch. bot. Gesell. 1885.

|| Ann. of Bot. vol. i.

¶ Hick (Journ. Bot. 1886) has described continuity between the protoplasts of some *Fucaceæ*. It would be interesting to know if callus is developed in these cases.

acid. In the sieve-tubes, on the other hand, there is upon the sieve-plates a substance which gives proteid reactions; two of these are shown in Plate XIV. figs. 11 and 12. It is evident that the callus of the trumpet-hyphæ is altogether different in constitution from that of the Vegetable-Marrow, and probably it is produced by mucilaginous degeneration of the cell-wall; moreover, it is unacted on by a peptonizing fluid.

I cannot conclude without recording my obligations to the authorities of Kew and the Natural-History Museum, through my friends Mr. J. G. Baker and Mr. George Murray respectively, for their kindness in providing me with material of *Ballia* and *Macrocystis*.

Summary.

1. Vegetable-Marrow callus gives with great clearness all the three chief proteid reactions; it is also dissolved by a peptonizing fluid; it is hence a typical proteid.

2. The callus cannot be pressed from the sieve, for (*a*) it is a proteid, (*b*) when it undergoes gastric digestion the sieve-plate is cleared, and is then left in its pristine condition.

3. The statements of the foregoing paragraph are supported by the entirely different reactions shown by wall and callus respectively.

4. *Ballia*-stoppers give all three proteid reactions, but are not attacked by a peptonizing fluid. They stain in the same way as does callus, except that they take a rich brown with iodine alone and are untouched by aniline-blue.

5. The stoppers react altogether differently from the wall, and to a very large extent similarly to the cell-protoplasm. The evidence of differentiation within their substance, as seen when boiled in Millon's fluid, and the fact of their disappearance under action of Schulze's macerating fluid into plasma-balls which still stain brown with iodine, speak for their similarity with cell-protoplasm.

6. The group of bodies allied to proteids, such as mucin, nuclein, chondrin, &c., contains none which gives in a typical fashion all three proteid reactions. Hence the substance of *Ballia*-stoppers should not be classified with them.

7. The callus of the Vegetable-Marrow has many of the characters of, and should probably be classed with, the *Coagulated*

Proteids: the substance of the *Ballia*-stoppers most closely resembles *Lardacein*.

8. The function of the callus, both of the Vegetable-Marrow and of *Ballia*, is to moderate the flow of proteids and direct it so that all the growing-points shall receive their due amount of the necessary pabulum. That the stoppers function as sealers-up of the pit is shown by the coincident growth of pit and stoppers.

9. Many of the phenomena presented by the dissolution and renewal of callus-masses upon sieve-plates recall to mind the action of ferments. In these cases it is, in all probability, a callolytic (proteolytic) ferment to which the effects are to be ascribed. This ferment has not yet been isolated.

Supplementary Note.

In the discussion which followed the reading of the above memoir, one of the speakers referred to Wiesner's * theory of cell-wall structure and to the observations relating thereto of Krasser † and Klebs ‡. It has been mentioned in the memoir that attention was paid to the proteid reactions of the wall, with the result that neither with the Vegetable-Marrow nor with *Ballia* did Millon's reagent or Copper Sulphate and Caustic Potash produce the slightest change of colour. Under these circumstances, I did not see the bearing upon the question of the above-mentioned researches, and I fail to see it now in the case of Vegetable-Marrow callus, which, since it is soluble in a gastric fluid, can obviously have no genetic relation whatever with the wall. With *Ballia*, however, it is different, and I am obliged to Prof. F. W. Oliver for his reference to the subject. It is open to any one to argue thus:—"True, the evidence brought forward that the stoppers are not formed by swelling-up of the wall is decisive; but when it is remembered how frequently the cell-wall contains either proteids or some nitrogenous substance or substances derived directly from destructive metabolism of proteids, it has not been proved that the stoppers, although they are deposited at the pit's mouth by the protoplasm, may not consist of a carbo-

* Sitzb. d. Wiener Akad. Band 93. † *Ibid.* Band 94.
‡ Bot. Zeitung, 1887.

hydrate framework largely impregnated with substances giving proteid reactions, and this would account for the insolubility in a peptonizing fluid." One method to resort to in such a case is to examine the stoppers for proteid after their sojourn in the gastric fluid; if the proteid reactions now fail, obviously the proteid will be merely an infiltration-substance. But if these reactions be now given, this may be due either to insolubility of the proteid in the fluid, or to the presence of nitrogenous decomposition-products. On referring to my notes, I cannot find that I actually tested for proteid after the action of the peptonizing fluid; my belief is that I did—indeed, it is obviously natural so to do: it is possible, however, that I may have relied upon the evident intactness of the stoppers, their form, size, and refringence being precisely the same after as before the action. There is, however, a crucial test applicable to the case; but before going into the matter further, it would be well to mention in a few words what are the views of Wiesner and his followers, and what are the objections which have been urged against them.

Wiesner's dermatosome theory of the cell-wall depends upon two facts:—(1) capacity of the wall to break up, on suitable treatment, into small definite particles or *dermatosomes*; (2) the presence of *living protoplasm* (*dermatoplasm*) in the cell-wall. The latter Wiesner holds to consist at first of protoplasm alone, and he contends that as long as the wall is growing it contains dermatoplasm. The cell-wall, which has a reticulate structure, consists of altered microsomes of the protoplasm, or dermatosomes; these are united by delicate strings of dermatoplasm, out of which are continually being formed, as long as the cell-wall is growing, at first new microsomes and then dermatosomes. Thus the cell-wall is, as long as it grows, a *living member of the cell*. Wiesner concludes that proteids exist within the walls of young cells, from the behaviour of the meristem at the vegetative point of the stem and of the cambium and phellogen of various plants. After acting upon these with a peptonizing fluid he asserts that he can get the cellulose reaction, not before. Upon this subject we have the observations of Mulder *, who, half a century ago, suspected the presence of proteid in the cell-wall, although Wiesner has himself shown that the facts upon which Mulder relied are other-

* Berzelius, Jahresber. 1840, p. 649; quoted by Krasser, Sitzb. Wien. Akad. Bd. 94.

wise explicable. More in point is the fact that Richter * showed the probability of the existence of proteid in the wall of fungus-cells, and that Nencki † has found proteids in the wall in the Bacteria (mycoprotein and anthraxprotein); while Forssell ‡, shortly after Wiesner, by means of Raspail's and Millon's reagents, discovered proteid in the wall of certain Lichen-hyphæ (*Lobaria pulmonaria*, *Peltigera canina*) and Algæ (*Gelidium cartilagineum*, *Ecklonia baccata*, &c.). We owe to Krasser an extended research upon this subject. He first made a careful study of all the non-proteid bodies which give one or more of the proteid reactions: thus he finds :—

The *Xanthoproteic reaction*, given by Tyrosin, certain resins and alkaloids.

Millon's reaction, given by starch, cotton-wool, and gum-arabic (as Millon himself found), Tyrosin, Phloroglucin, Phenol, Thymol, Vanillin, Naphthol, Nitrobenzole, and aromatic oxyacids.

Raspail's reaction, given by oil, certain fats, Tyrosin, Phenol, Thymol, Naphthol §.

Fröhde's test (blue colour with Molybdic Acid and Hydric Sulphate), given by Glycerin, Tyrosin, Mannite, gums, cane-sugar, Phenol, Phloroglucin, Thymol, Vanillin, Coniferin.

Krasser's Alloxan reaction (purple-red colour with watery solution), given by Tyrosin, Aspartic Acid, Asparagin.

The upshot of Krasser's labour was the conviction that living protoplasm is present in the cell-wall of Fungi (hyphæ of *Polyporus sulphureus* and *P. fomentarius* and of several Lichens), Algæ (*Chondrus crispus*, *Cladophora* and *Œdogonium* spp., &c.) (failure with *Chætophora*, *Spirogyra*, *Zygnema*), *Chara*, leaf-cells of *Polytrichum*, several Vascular Cryptogams, meristem of Phanerogams (vegetative point, pericambium, phellogen), epi- and

* Sitzungsb. d. Wiener Akad. Band 83.

† Journ. f. prakt. Chemie, Neue Folge, xx., and Ber. d. deutsch. chem. Gesell. Jahrg. xvii.; both quoted by De Bary, 'Vorlesungen über Bacterien,' Engl. transl. p. 4.

‡ Sitzungsb. d. Wiener Akad. Band 93. See also Frémy, Ann. Sc. Nat. 6 sér. t. 13.

§ Precipitates are formed in these last two cases; they constitute Molisch's Sugar-reactions (violet with naphthol, rusty-red with thymol; *vide* Molisch, Anz. d. k. Akad. d. Wiss. Wien, 1886, p. 97).

hypodermal tissue, collenchyma, tendrils (*Bryonia*, *Cobæa*, *Cucumis*, *Vitis*), endosperm cells (occasionally). Moreover, by taking proper precautions, he claims to have found protoplasm also in the xylem- and phloem-fibres of several plants.

These views of Krasser and Wiesner have met with severe handling on the part of Klebs * and Fischer †. Klebs holds that, even if there be proteid in the cell-wall, which has not been proved, there is no justification for the supposition that we have to do with organized living protoplasm. He favours Strasburger and Schmitz's ‡ theory of the origin of the cell-wall, viz. that the peripheral layer of protoplasm is directly changed into cellulose; and as an example of the rapid way in which this transformation takes place, he cites the membrane around ejected plasma-masses of *Vaucheria*. This cannot be living protoplasm, for, by contracting the latter in a weak solution of syrup and staining with Congo-red—a dye which is not taken up by protoplasm—we learn that cellulose has been formed. He also, by employing Löw and Bokorny's § alkaline silver-solution method, which Krasser himself had partially relied upon, finds that, if Krasser's application of the method be correct, there is unmistakable evidence of protoplasm in the wall of the pitted tracheides of young Maize plants, while the other cells react very much less clearly! Fischer believes it impossible to distinguish proteid by micro-chemical means alone; he says that morphological and developmental facts must always be adduced, and he submits Krasser's results with Bromeliaceous leaves to very damaging criticism. He shows, too, that it is not the presence of proteid which hinders the cellulose reaction in the case of young membranes, but that time is required to stain them blue with Schulze's solution. Also that in some cases (sections of *Nidularium* leaf, of the cotyledon of the bean, and of endosperm of *Ricinus*) the cell-walls take the same colour with Millon's reagent after, as before, the action of a peptonizing fluid. He thinks it probable that not proteid, but some substance resulting from direct destructive metabolism of proteids, probably Tyrosin, gives the reactions upon which Krasser and Wiesner rely. To

* Bot. Zeitung, 1887. † Ber. d. deutsch. bot. Gesellsch. 1887.

‡ Strasburger, Ueb. d. Bau und d. Wachs. de Zellhaüte; Schmitz, Sitzungsb. d. niederrh. Gesellsch. in Bonn, 1880.

§ Die chem. Kraftquelle im lebend. Protoplasma: München, 1882.

these strictures Wiesner * has replied, but without materially advancing the theory.

Is some such substance present in *Ballia*-stoppers? Bearing in mind the identity in proteid-reactions shown by stoppers and protoplasm (omitting, of course, the brighter colour with Millon's fluid taken by the stoppers), one is inclined to say no. In order to decide the question, however, experiments have been made with fluids in which the non-proteid substances giving Millon's reaction are soluble.

It may be premised that Phloroglucin cannot be present, for Hydrochloric Acid gives no red colour to the stoppers. Of the bodies that remain, Nitrobenzole, Phenol, Thymol, and Naphthol are readily soluble in alcohol and ether. Accordingly pieces of *Ballia* were allowed to lie in strong alcohol for 36 hours, and, on now testing with Millon's fluid, the bright red colour was at once got. As for Tyrosin, it is soluble in acid and alkaline solutions; but on testing with Millon's fluid after 36 hours' action of a strong solution of Hydrochloric Acid, the red colour was easily yielded. Vanillin is soluble in water; 90–100 parts are required at 14°, and 20 parts at 75°–80° †; but on soaking *Ballia*-plants in water for three days and afterwards boiling for five minutes, Millon's reaction was as readily obtained as ever. There remains the small and obscure group of aromatic oxyacids; but I cannot see the slightest chance of the proteid reactions of the stoppers being due to them.

[*Supplementary Note to Memoir on* Apiocystis Brauniana, *Näg. in Journ. Linn. Soc. Bot.* xxv. (1890), pp. 362–380.—In the memoir on *Apiocystis* a few notices of the distribution of this alga escaped me. On referring to the recently issued and elaborate 'Sylloge Algarum' of Dr. De Toni (Padua, 1889), it appears that *Apiocystis* has been found in Sweden, Russia, Bohemia, and in the United States. There is also a paper in the 'Annales des Sciences Naturelles' (sér. 7, tome vii. p. 158) by M. Dangeard, in

* Ber. d. deutsch. bot. Gesellsch. 1888. See also Krasser, Bot. Zeit. 1888. Kohl (Bot. Centralbl. vol. xxxvii.) and Krabbe (Pringsheim's Jahrb. f. wiss. Bot. xviii. pp. 352–354) write against Wiesner's theory.

† Roscoe and Schorlemmer, 'Treatise on Chemistry,' vol. iii. part 4, p. 354.

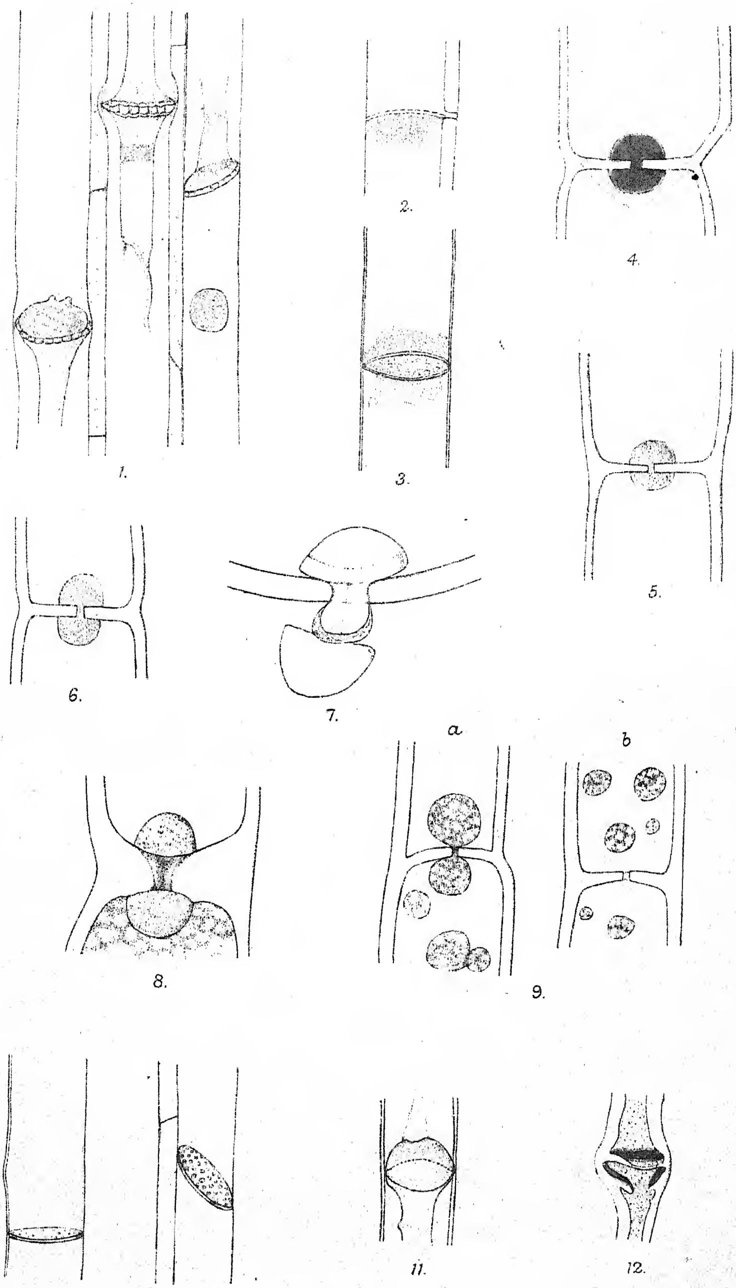
which mention is made of an examination of *Apiocystis*, so that the alga would appear to occur also in France. Professor Bower tells me that he found *Apiocystis* while working, some years ago, in the late Professor de Bary's Laboratory at Strassburg. Other British localities are Aberdeen (*Roy*) and Yorkshire (*West*), according to Mr. A. W. Bennett in Journ. Roy. Micros. Soc., Feb. 1890. See also Mr. West in Journ. R. Micros. Soc., June 1890.

Professor Hansgirg's memoir "Ueber den Polymorphismus der Algen" (Bot. Centralbl. Band xxii. p. 200) was overlooked by me. Hansgirg imagines a number of algal types, including such apparently distinct ones as *Nephrocytium*, *Oocystis*, *Dictyosphæria*, *Characium*, *Hydrianum*, &c., to be mere pleomorphic forms of various *Chætophoraceæ*, *Siphonocladiaceæ*, *Ulvaceæ*, &c. He is unfortunate in including *Apiocystis* in this list; and one can scarcely suppose that even careful research will confirm all this botanist's ideas.—*S. M.*]

EXPLANATION OF PLATE XIV.

Fig. 1. Vegetable-Marrow. Sieve-tubes and companion cells: xanthoproteic reaction (reaction of wall not shown). ×450.

2. Ditto. Millon's reagent. ×450.
3. Ditto. Copper Sulphate and Caustic Potash (the dirty-pink colour). ×450.
4. *Ballia callitricha*, Ag. Millon's reagent. ×450.
5. Ditto. Xanthoproteic reaction. ×450.
6. Ditto. Copper Sulphate and Caustic Potash.
7. Ditto. Stoppers after 30 hours' action of the peptonizing fluid. Pit and connecting-protoplasm well seen. (Drawn with mag. of 600 diam. and enlarged.)
8. Ditto. Shows effect of boiling for one minute with Millon's fluid. The colour has flown and granular precipitation is visible in the stoppers; protoplasmic reticulum still visible. ×600.
9. Ditto. Shows action of Schulze's macerating fluid: (*a*) the stoppers have melted into the two balls of plasma which still remain at the pit's mouths; (*b*) plasma separated from pit, showing the latter quite empty. ×450.
10. Vegetable-Marrow. Effect of a peptonizing fluid: the sieves are quite clear, and no trace of callus is visible. ×450.
11. *Macrocystis pyrifera*, Ag. Callus upon sieve-plate of a sieve-tube: xanthoproteic reaction. ×600.
12. Ditto. Effect of Millon's reagent upon callus of sieve-tube. ×450.



S. L. Moore del.
R. Morgan lith.

West, Newman imp.

PROTEID REACTIONS OF CALLUS.

Studies in Vegetable Biology.—VII. Some Microchemical Reactions of Tannin, with Remarks upon the Function of that Body and its Excretion from the General Surface of Plants. By Spencer Le M. Moore, F.L.S.

[Read 17th April, 1890.]

About eighteen months ago, happening to have by me some of the fluid proposed by Nessler many years since as a test for ammonia (solution of potassium iodide saturated with mercuric iodide to which caustic potash is added), the idea occurred to try whether this would be of any value in the microscopical study of tannin by the botanist. It was found that with solutions of tannin a dark-brown precipitate is thrown down by Nessler's fluid; hence one would expect to find the brown colour imparted to tannin when in the cell of a tissue. Since that time many experiments have been made, with the result—already briefly announced in 'Nature'*—that the fluid in question is likely to prove a valuable auxiliary to the already long list of tannin-reagents at the botanist's disposal. Just as with iron salts the effect produced is not always the same, so too with Nessler's fluid. That it may not be thought that some other substance or substances besides tannin gave the reactions hereafter to be described, it must be remarked that great care was taken to accumulate evidence, both positive and negative, as to the reactions being due to tannin in one of its forms, and to tannin alone. It is, however, unnecessary to dwell upon this matter, since it has already been set forth in the letter to 'Nature.'

Besides the brown colour spoken of in the letter, further research has brought out a good deal of difference in the behaviour of Nessler's fluid towards tannin. Three kinds are to be distinguished, viz.:—

I. Tannin giving an immediate brown precipitate, occasionally with decided brown-pink tendency.

II. Tannin giving a yellow colour, quickly becoming red-brown, and, finally, a cold brown precipitate.

III. Tannin giving a yellow colour, the yellow substance readily diffusing through the cell-walls into the surrounding fluid, thus leaving the cells colourless after a varying lapse of time.

* Vol. xli. p. 585.

Group I. (Immediate brown precipitate.)

In the fundamental tissue of *Musa sapientum* run numerous large tannin-sacs in the neighbourhood of and parallel to the course of the vascular bundles *. Nessler's fluid immediately turns this tannin a fine rich brown.

Epiderm (upper and lower) of leaf of common Primrose. Numerous tannin idioblasts are scattered among the ordinary cells, which latter are well provided with chlorophyll.

Rosa canina. The tissues in the neighbourhood of the apical meristem of the stem are richly provided with tannin immediately giving the brown colour. The same is the case with the garden Rose.

Epiderm of *Grevillea robusta.* Tannin occurs plentifully in the cells overlying the vascular bundles on the lower side of the leaf, also in a few cells in their immediate neighbourhood: elsewhere tannin is restricted to the two subsidiary cells which lie on each side of the stomatal guard-cells.

Group II. (Yellow colour, changing through red-brown to brown.)

A good example of the occurrence of this kind of tannin is the fundamental tissue of the young stem of *Aucuba japonica.* At first the colour is a pronounced yellow; but in a few minutes this gives place to brick-red, which is itself supplanted by a warm brown. After a few days in glycerine, the colour of the tannin-precipitate in such a preparation changes to a cold brown.

Group III. (Readily diffusible yellow colour.)

This has been frequently met with. As instances, may be cited the following:—

Leaf-scales of scape of *Petasites vulgaris* and *Tussilago Farfara.*

Ivy. Fundamental tissue of young stem and the large stellate hairs clothing it.

Dandelion. Fundamental tissue of underground stem.

Potentilla Anserina. Hairs thickly covering the plant.

Hairs on stipules of *Rosa canina.*

* De Bary, Vergl. Anat. p. 160 (Engl. transl. p. 153).

Chestnut. Abundance of this kind of tannin in the cells of the bud-scales.

The chief value of Nessler's fluid to the microscopist is that, apparently in consequence of the rapid diffusibility of caustic potash, its action in showing up any tannin-containing cells in a tissue is very quick. This valuable property is alluded to among the further details to be now given.

Group I. Primrose epiderm.—To see the tannin in this plant, the easiest way is to tear off pieces of epiderm from the underside of the leaf, and mount them in the testing-fluid. The strips should include some cells overlying a vascular bundle. With Nessler's fluid one immediately sees that tannin idioblasts are present in some numbers in the elongated cells overlying the vascular bundles, and from the very dark, frequently quite black, colour of the precipitate, the richness of these elements in tannin is manifest. Numerous tannin idioblasts are, as has already been mentioned, scattered among the ordinary epidermal cells: the latter contain a nucleus and numerous chlorophyll corpuscles, which, contrary to what is usually the case, are about the same size as those of the guard-cells. The guard-cells give no sign of tannin, and it is rather rare to find tannin idioblasts bordering on them *. The hairs covering the leaves consist of a simple row of cells, and show a curious disposition of the tannin; as a rule, the alternate cells are tannigerous, the intervening ones have chlorophyll and are without tannin; the proximal cell of the hair may have tannin, or be a chlorophyll-cell.

Besides Nessler's fluid, the only ordinary reagent able to show up the tannin of the Primrose without any loss of time is osmic acid in 1-per-cent. solution, which causes the well-known inky-blue precipitate to be thrown down in the tannin elements. As an illustration of the long time required to stain the tannin-cells in such a case as Primrose epiderm, if the ordinary tests are used, the following Table is subjoined.

* At an earlier stage the tannin-idioblasts contain chlorophyll; but they can be at once picked out from their neighbours on account of the smaller number of their chloroplasts; afterwards the chlorophyll disappears from them.

Reagent.	Time during which experiment lasted.	Effect produced.
Iron acetate ...	12.55 P.M. to 4 P.M.	Tannin not yet completely shown up.
Ferrous sulphate......	2.45 P.M. to 4 P.M.	Effect imperfect.
Potassium bichromate.	11.30 A.M. to 4 P.M.	Many idioblasts well stained, but many not yet stained or but slightly.
Ammonium molybdate.	11.15 A.M. to 4 P.M.	Many cells beautifully coloured; many not coloured at all. Addition of ammonium chloride to the molybdate caused no perceptible difference.
Copper acetate.	1.20 P.M. to 4 P.M.	A pale yellow-pink or pale brown colour in most of the tannin-cells.
Copper sulphate	3 P.M. to 4 P.M.	Grey precipitate in a few of the tannin-cells.

On examining, next morning, strips of epiderm placed overnight in the above solutions, the effect characteristic of each was well seen.

In the subsidiary cells of *Grevillea robusta* the tannin shows up immediately with Nessler's fluid, as also with osmic acid. Some of the ordinary reagents, such as iron acetate, will act directly upon a few of the cells; but many cells remain uncoloured, and several hours must elapse before they stain. It is further to be noted that in every case in which an immediate brown precipitate is given with Nessler's fluid, a blue-black precipitate is thrown down with iron salts.

Group II.—We have seen that tannin in *Rosa canina* gives a brown precipitate with Nessler's fluid; but the hairs upon the young leaves take at first a yellow colour, and in some of them this passes into a brown. It would hence appear that we have two kinds of tannin in these hairs. Nor is this matter for wonder, since Dufour * finds both iron-blueing and iron-greening

* Bull. Soc. Vaud. 1886. Abstracted in Journ. R. Micros. Soc. 1887, p. 257.

tannin side by side in the same tissue, viz. the epiderm of *Sedum Telephium*.

Group III.—The use of Nessler's fluid is especially valuable here, inasmuch as other reagents may not act within a reasonable time. Strictly speaking, however, it is the caustic potash which produces the effect; indeed any alkali will give the yellow colour with this form of tannin, as has been known for many years. So far as I am aware, Wiesner * was the first to draw attention to this matter, and he also noticed that this alkali-yellowing tannin gives a green precipitate with iron salts. I can confirm Wiesner on this point, as in every case in which the yellow colour has been given with Nessler's fluid, iron salts have thrown down a green or greenish-yellow precipitate. The chief point to note is the light yellow colour immediately given with Nessler's fluid, as also with alkalies, and (what has not, it is believed, been observed before) the diffusion of this coloured matter through the cell-walls, so that after a few minutes the piece of tissue under examination is surrounded by a yellow halo easily visible to the naked eye. Take, as an example of the occurrence of this tannin, the scales of the scape of *Petasites vulgaris*; the following remarks apply to the epiderm alone, but tannin occurs elsewhere as well. Nessler's fluid immediately brings out the yellow colour in all the cells except the guard-cells of the stomata, and the tissue is soon rendered colourless for the reason just given. Osmic acid within three minutes stains almost all the cells a pale slaty grey, a colour which osmic acid always gives, at least as far as one's observation goes, with the iron-greening tannin. Ferric chloride immediately gives a dark green precipitate in all the cells, and potassium bichromate acts pretty fairly after some time, half an hour at least. Many cells are at once stained the beautiful and characteristic colour with ammonium molybdate; but even after two hours only groups of cells are coloured. Again, the large stellate hairs closely set upon the axis and appendages at the growing-points of the Ivy—the ordinary reagents are not nearly so satisfactory in this case as in the last, for, whereas the action with Nessler's fluid is immediate, with ferric chloride a couple of hours must elapse before the green precipitate is thrown down. Ammonium molybdate will colour a few of the hairs within ten minutes, but many remain unaffected a much longer

* Bot. Zeit. 1862.

time; while for the slaty colour with osmic acid one must wait half an hour or so. Potassium bichromate also is slow in its action.

The close relation between the colouring-matters which occur dissolved in the cell-sap, and are known under the general term anthocyan, is admitted by most physiologists *. This is what happens when cells containing anthocyan (*e. g.* epiderm of red-cheeked apples, hairs of *Escallonia macrantha* and of *Petasites vulgaris* scales) are acted on by Nessler's fluid. The red colour is almost instantly turned a fine deep green, which soon passes into yellow and this into brown. If caustic potash alone is used, the effect is the same except that the brown stage is not reached. Here, too, one sees how valuable an aid Nessler's fluid is likely to prove: for instance, De Vries †, in his study of the contents of *Drosera* tentacle-cells, used Möll's test for the discovery of tannin, and this involved waiting for twenty-four hours, whereas with the new reagent his inquiry would have been answered in a few minutes.

Failure might, perhaps, be deemed probable with cells containing much free acid, since the action of Nessler's fluid is due in large measure to an alkali. But, so far as concerns two of the commonest acids occurring in plants, this is not the case, for on charging a solution of tannic acid with either citric or oxalic acid, the precipitate is still obtained with Nessler's fluid.

Added to a solution of tannin or tannic acid Nessler's fluid throws down a precipitate which is momentarily of a reddish colour, then changing to brown. Other reactions are as follows:—

With Gallic Acid	it gives	a grey-green precipitate.
„ Pyrogallol	„	a brown precipitate immediately (no momentary red).
„ Pyrocatechin	„	a deep green precipitate, soon turning to greenish brown.
„ Protocatechic Acid	„	a dirty-green precipitate.

These precipitates are probably all of them oxidation-products;

* On this point see, for instance, Wigand, Bot. Zeit. 1862, and Forsch. aus d. bot. Garten zu Marburg, Heft ii. (1887); Wiesner, Bot. Zeit. 1862; Went. Jahrb. f. wiss. Bot. Band 19; Pick, Bot. Centralbl. 1883; Dennert, Bot. Centralbl. 1889.

† Bot. Zeit. 1886.

but further information on this subject can scarcely be expected from a botanist.

A few words now, before proceeding to speak of some other tannin-reactions, about the "glucoside or glucoside-like substance" recently found by Haberlandt * in the drops of fluid exuding from cut surfaces of *Mimosa pudica*, and called by former authors "water-drops." This substance is met with in certain large elements scattered through the leptom, which Haberlandt believes is the path taken in the conduction of a stimulus from one part of the plant to another; it is strongly acid, and is held by Haberlandt, and apparently with reason, to be the substance by whose osmotic activity is brought about the relatively high degree of turgescence the abolition of which on sectioning results in exudation of the drop. With iron salts a purple colour is taken by it, as Haberlandt shows, and, on heating with acids, a body-reducing copper oxide is formed.

Had Haberlandt applied some other tests he would have found that not only is the body in question a glucoside, but that it is tannin or tannic acid. Thus ammonium molybdate gives a decided yellow, and potassium bichromate a brown colour to the crystals which rapidly form in the exuded drop, and the development of which is a very pretty sight. Nessler's fluid is less satisfactory: a well-marked yellow solution is obtained with it, and a slight brown residue which has to be carefully looked for. It is necessary, in applying these reagents, to use them in very small quantities, otherwise the result sought for will not be reached; so, too, with iron salts, it is only at the junction of tannin with salt that the purpling occurs.

It may be stated as a general rule, that addition of caustic potash to a tannin-reagent quickens its action. Thus if it reinforces ammonium molybdate an immediate, though faint yellow colour is given to the idioblasts of the Primrose and to the subsidiary cells of *Grevillea robusta*. But inasmuch as caustic potash alone will produce a closely similar effect, it is not certain whether the molybdate cooperates in this. With caustic potash and iron sulphate an almost immediate purple or purple-black precipitate is thrown down in the cells of the Primrose; but all experiments with these two bodies have proved unsatisfactory on account of the precipitate caused by their coming in contact.

* 'Das Reizleitende Gewebesystem der Sinnpflanze,' Leipzig, 1890.

More useful is a mixture of iron acetate and caustic potash, which rapidly colours tannin a brown-pink. With copper sulphate and potash also the effect is marred by the presence of a precipitate: the tannin idioblasts of the Primrose are coloured straw-yellow by this means, and with copper acetate the action, formation of a greyish precipitate, is uncertain. Nessler's fluid without the mercuric iodide, *i. e.* caustic potash with potassium iodide, gives, in the few cases in which it has been tried, a quickly-got pale brick-red colour. This is a reagent which ought to be further studied, inasmuch as it is free from an objection to the employment of Nessler's fluid founded upon the poisonous nature of mercuric iodide. Addition of caustic potash to potassium bichromate is of no use. A modification of Möll's test, in that iron sulphate was substituted for acetate, turned out satisfactory, at least in the case of the Primrose epiderm, since after overnight action of copper acetate the sulphate threw down a precipitate of iron tannate directly, whereas the acetate did not do so for some ten minutes.

What one is inclined to consider a fact of some importance to plants, has come to light in consequence of these experiments with tannin. It has been already mentioned that one form of tannin turns yellow with Nessler's test, and that this yellow fluid diffuses out of the cell. It must be confessed that the meaning of this quite escaped me until I came upon Wiesner's * paper, in which it is stated that alkalies generally will colour the iron-greening tannin a bright yellow. The importance of the diffusibility of this alkali-yellowing substance is seen when the constant presence of ammonia in the air and in rain-water is remembered. But it is necessary to inquire whether the minute quantities of ammonia found in the air and in rain-water are sufficient to convert the tannin into a yellow diffusible substance. To answer this question a few experiments have been made with the Ivy; in the course of these it was ascertained that exceedingly weak solutions are capable of acting in the above capacity. Thus a 1-per-cent. solution of ordinary "liquor ammoniæ" of the shops—itself a diluted solution—gives a pronounced yellow colour to the hairs, epiderm, and fundamental tissue of the young Ivy stem,

* Bot. Zeit. 1862. Pfeffer (Ber. d. deutsch. bot. Gesell. 1886) has noticed that the tannate formed by action of methyl-blue upon a tannigerous tissue diffuses out into the surrounding medium.

and even with a 0·5-per-cent solution, to which Nessler's fluid imparts a scarcely visible yellowing, the yellow colour is clearly enough seen in many of the hairs and epidermal cells. Let us now see how this operates in nature. A wet day comes, and the leaves and stems of herbs, shrubs, and trees are flooded with water containing ammonia in solution; this must obviously cause diffusion of epidermal and trichomal tannin in the form of the yellow substance in question, and one can scarcely resist the conclusion that the whole surface of the plant—at least in the case of herbaceous plants—must play under these circumstances an excretory rôle. And since dew contains a much higher proportion of ammonia than does rain-water, the argument applies with yet greater force to the nightly vicissitudes to which vegetation is exposed.

But the case becomes even stronger when we consider underground parts. Among other ways in which ammonia is accumulated in the soil, we know that decomposition of nitrates and of nitrogenous organic bodies is ever going forward in consequence of the activity of ammoniopoietic micro-organisms, and it can scarcely be questioned that this soil-ammonia must be an efficient agent in the excretion of tannin.

Numerous as are the writers who have treated of that obscure subject the function of tannin, one can scarcely admit that any of them has made us much the wiser for his pains, though this is scarcely a matter for special remark, in view of the abstruseness of the theme *. Some would have us believe that the tannins,

* Among the chief authors of recent memoirs on tannin are the following; in each case the writer's views as to the function of tannin are succinctly stated within brackets:—Sachs ('Vorlesungen,' no. xi.) [Excretory and assimilative]. Kutscher ('Flora,' 1883) [Excretory and assimilative]. Gardiner (Proc. Camb. Phil. Soc. vol. iv. p. 388) [Excretory]. Vines ('Physiology of Plants,' p. 234) [Decomposition-product, but indirectly assimilative]. Kraus (Ber. Sitzb. naturf. Gesell. Halle, 1884; abstr., Journ. R. Micros. Soc. 1886) [Reserve substance]. Westermaier (Sitzb. d. Berl. Akad. 1885 and 1887) [Assimilative]. De Wildeman (Bull. Soc. Roy. Bot. d. Belgique, 1886) [Assimilative]. Dufour (Bull. Soc. Vaud. 1886; abstr., Journ. R. Micros. Soc. 1887) [Excretory]. Schulz ('Flora,' 1888) [Assimilative]. A. Fischer (Bot. Zeit. 1888) [Assimilative]. Hillhouse ('Midland Naturalist,' vols. 10 & 11) [Excretory]. Moeller (Ber. d. deutsch. bot. Gesell. 1888) [Assimilative]. Stahl ('Pflanzen und Schnecken' in Jen. Zeitschr. f. Naturwiss. 1888) [Protective against animals]. G. Kraus ('Grundlinien zu einer Physiologie d. Gerbstoffs,' Leipzig, 1889; abstr. Journ. R. Micros. Soc. 1889) [Antiseptic, excretory, and protective against animals].

such ready yielders of that important translocation-product glucose, are entirely excrementitious; others hold them to be themselves translocation-products; while a middle course is steered by yet others, who think that both functions, assimilative and excretory, are performed by these bodies. An antiseptic rôle has also been ascribed to tannin, and, on account of its bitterness, it has been supposed to protect plants against the depredations of animals.

I cannot help thinking that it is rash to argue, because direct participation of tannin in metabolism is not discoverable, that therefore it is an excretory substance. An important part may possibly be taken by it in the lignification of cell-walls; but it will not be necessary to treat of this matter except to refer to the apparent presence of glucosides in lignified cell-walls *. In tannin we have a glucoside which is present often in great quantities in the plant-tissues: it undoubtedly moves from one part to another, and its production depends upon conditions favourable to metabolism. On the other hand, it cannot be distinctly shown to participate in metabolism. What, then, can have become of it? Is the glucoside in lignin formed afresh when there is already plenty of tannin in the plant? And even with regard to the iron-greening tannin, which we have seen reason to believe is largely excreted from the surface of plants †, and which is doubtless primarily a waste product, it must be remembered, since Nägeli ‡ has found that tannin can function as the source of carbon to fungi, that the metabolism of fungi may perhaps involve katabolism of quasi-useless bodies, such as tannin, and production of substances capable of being used up in the nutrition of higher vegetation.

Busgen (Jen. Zeitschr. f. Naturwiss. 1889) [Protective against animals: share, if any, in constructive metabolism not yet proven].

* See Vines, 'Physiology of Plants,' Lecture ii., with the bibliography there given.

† The storing up, by the temporary hairs of glabrate organs, of tannin formed in the meristem may also be a means whereby the plant is enabled to rid itself of the glucoside. The hairs of the Ivy, for instance, are large and can contain a relatively great quantity of tannin, and they soon drop off. But Schenk ('Vergleichende Anatomie der submersen Gewächse,' quoted by Stahl in Jen. Zeitschr. f. Naturwiss. 1888, p. 594) regards the caducous tannin-filled hairs of *Ceratophyllum* as a special protection for the young organs.

‡ Sitzb. der k. bayer. Akad. der Wiss. 1880, p. 339. See also Van Tieghem, 'Traité de Botanique,' p. 542.

In the epiderm of the Primrose we find tannin idioblasts scattered among the chlorophyll-containing cells, and we have already seen how, in earlier states of the leaf's development, these idioblasts are only distinguishable from the cells among which they lie by their containing fewer chlorophyll corpuscles, although even now they have much tannin. What is it which determines whether a cell shall become an idioblast or remain a chlorophyll cell? What happens is probably this:—One consequence of cell-metabolism is the formation of tannin, and this tannin is passed on from cell to cell either by diffusion through the wall or by active movements of the connected protoplasts *. The cells, then, besides manufacturing tannin, are continually receiving it from other cells and passing it on; the tannin-streams† will thus obviously tend to converge towards certain points, and at these points tannin will accumulate. Accumulation of tannin is unfavourable to metabolism, and after a time the cell will degenerate to a mere passive recipient of tannin from other cells. But there must also be lateral movement in the epiderm to the idioblasts overlying the vascular bundles, for there is almost always more tannin in these idioblasts than in those situated in other parts of the epiderm ‡, and it is this evident movement of tannin towards the conducting tissues which would seem to argue for it some other than a merely excretory rôle. Whether the tannin is of any service to the plant while in the idioblast is not at all clear. Of course it may preserve the leaf from the attacks of injurious animals (insects &c.); but when one recalls Haberlandt's recent discovery relative to tannin (or rather tannic acid) as being the osmotically active substance in *Mimosa pudica*, and connects with it the fact that the tannin-idioblasts of the Primrose are almost always after a time somewhat, and often markedly

* Either method is possible; for on the one hand Vesque ('Comptes Rendus,' 1886; abstr. Journ. R. Micros. Soc. 1887) finds that water passes with great ease from one epidermal cell to another; and continuity of protoplasm is often to be seen with exceptional clearness in the epiderm (*e. g.* Schaarschmidt, Magy. Növ. Lapok, 1884, abstr. Journ. R. Micros. Soc. 1885; and Tangl, Sitzb. d. k. k. Akad. Wiss. Wien, 1884).

† That there are such streams is proved by the existence of the so-called tannin-bridges (*vide* Moeller, Ber. d. Deutsch. bot. Gesell. 1888).

‡ This point was enunciated in the writer's second memoir on "Light and Protoplasm" (Journ. Linn. Soc., Bot. xxiv. p. 377). Some months after the reading, but a little while before the publication of that memoir, Moeller (*l. c.*) made the same discovery.

larger than the chlorophyll-cells, one is inclined to ask whether the presence of these idioblasts may not be connected with the closing movement of the stomata. And, lastly, why may not tannic acid have some general relation to the turgescence of cells?

SUMMARY.

1. Nessler's test for ammonia is a valuable aid to the botanist in detecting with certainty and rapidity the presence of tannin and tannic acid in plants. Other fluids, having caustic potash for a basis, are also good reagents for tannin.

2. Two chief kinds of tannin are to be distinguished, according to their behaviour with Nessler's fluid: (*a*) the iron-blueing tannin strikes brown with the fluid, (*b*) the iron-greening variety is turned yellow by it.

3. The yellow substance just mentioned readily diffuses through the cell-wall; this effect is to be ascribed to the caustic potash, for alkaline solutions, even the weakest, will act in the same way. Here we have a provision, by the aid of rain, dew, and activity of soil-organisms, for the excretion of tannin from the general surface of all plants containing this form of it.

4. In addition to the functions hitherto ascribed to tannin, Haberlandt's recent discovery with reference to the 'water-drop' exuding on section from *Mimosa pudica*, renders it possible that tannic acid may have a more general relation to the turgescence of cells. Moreover, tannin is most likely used up in the lignification of the cell-wall.

5. The diffusible tannin, although primarily excretory, and the non-diffusible kind when occurring in shed organs, may yet, in view of the fact that tannin can act as a source of carbon to fungi, have some indirect connection, *viâ* the nutrition of Saprophytes, with the metabolism of green plants.

INDEX.

END OF THE TWENTY-SEVENTH VOLUME.

PRINTED BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.